Engineers Australia

Engineering Heritage Victoria

Nomination

Engineering Heritage Australia Heritage Recognition Program

CHAFFEY BROTHERS IRRIGATION WORKS IN AUSTRALIA

February 2017

Front Cover Photograph Caption

The triple expansion steam engine designed by George Chaffey and built by Tangye Brothers, Birmingham which provided the first stage of pumping from the Murray River to Kings Billabong until replaced by electric pumps.

The engine has been restored and is cared for and run by a group of Mildura volunteers.

The use of marine type triple expansion steam engines direct driving to multiple centrifugal pumps was extremely innovative when George Chaffey designed the engine in the late 1880s however the date of the order on Tangye Brothers is not known.

Image: Heritage Victoria.

TABLE OF CONTENTS

1 Introduction

George and William Chaffey made significant contributions to the development of irrigation for agricultural land in dry climates with several successful projects in California and at Mildura and Renmark in Australia.

Their combined skills allowed them to integrate engineering, social, commercial and agricultural techniques to develop irrigation colonies in very aggressive environments. Their work laid down principles which were followed by others enabling large scale irrigation projects which now contribute greatly to agricultural output in many arid and semi-arid parts of the world.

Engineer George Chaffey pushed the limits of the use of centrifugal pumps to achieve efficient, high volume pumping at an affordable cost for irrigation work. He also developed his skills to lay out efficient channel networks to distribute water over large areas with water delivered to the highest point of each block by gravity.

William pioneered the dried fruit industry and the wine-making industry at Mildura and helped to establish Australian excellence in those industries which continues to the present time.

The Chaffey colonies were, however, subject to serious disputation and public ridicule largely because of flaws in the financial models adopted for the colonies. This led to the establishment of Irrigation Trusts to operate, maintain and expand irrigation systems in return for rates from the landowners. This model proved to be more sustainable and brought stability and prosperity to irrigation areas.

The personal characteristics of the brothers are a model for all engineers. They were hard-working, not deterred by the many set-backs they encountered and they took breathtaking engineering and commercial risks in order to innovate. They combined a wide range of skill and high professional ethics in a way we should all admire.

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Early agriculture in Australia centred on the fertile valleys of the east and south coasts whilst grazing of sheep and cattle in the drier areas west of the Great Dividing Range followed close behind. It was not until the 1880s that attention turned to the development of irrigation schemes, primarily in the Murray-Darling Basin. The first such projects were in the Goulburn Valley in Victoria and the Chaffey brothers projects in Mildura in Northern Victoria and Renmark in South Australia.

Whilst there were difficulties in getting early projects operating successfully the legendary persistence of Australian farmers prevailed. Australia now produces about 23% of its gross agricultural product from irrigated farms which together account for only 1% of all land used for agriculture and grazing in Australia [1]. The value of produce from irrigated farms reached A$13.4 billion in 2012/13 [2].

The Chaffey brothers George and William came to Australia in the late 1880s with considerable experience from developing irrigation colonies in California in the United States of America. They negotiated arrangements with both the South Australian and Victorian colonial governments and established successful irrigation colonies at Renmark and Mildura.

Others built on their work, the Murray in particular gradually acquired a high level of flow regulation from a series of weirs and locks and large storages were constructed to supply water over the annual cycles and through droughts. Water is now diverted from the eastern slopes of the Snowy Mountains via the Snowy Mountains Hydro-electric Scheme power stations to provide irrigation water along the long course of the Murray River.

[1] Australian Bureau of Statistics, Drought drives down water consumption, Media Release, November 2006.
[2] Australian Bureau of Statistics, Water Account, Australia, 2012-13, retrieved 8 August 2015.

2 Heritage Award Nomination Letter

Learned Society Advisor
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of work: **Chaffey Brothers Irrigation Works in Australia**

The above-mentioned work is nominated to be awarded an Engineering Heritage National Marker.

The Chaffey Irrigation schemes in Australia were based in Mildura, Victoria and Renmark, South Australia. The grid references for the centre of these towns are:

- Mildura: lat -34.183474º south, long 142.164622º east
- Renmark: lat -34.171646º south, long 140.750591º east

There are no specific owners identifiable as the towns, their, residents, the municipal councils and bodies of state governments are all stakeholders in the irrigation assets of the areas.

The owner of the land where the interpretation panel is proposed to be located has been advised of this nomination and a letter of agreement is attached.

Access to site: Most areas of the town on which significant surviving assets from the early irrigation colony are accessible to the public. Farms lands and food processing factories are only accessible with the permission of the owner.

The Nominating Body for this nomination is Engineering Heritage Victoria with the full support of Engineering Heritage South Australia.

David LeLievre
Chair
Engineering Heritage Victoria

Date: February 2017

3 Heritage Assessment

3·1 Basic Data

Other/Former Names: Mildura Irrigation Colony, Renmark Irrigation Colony
Location: The Chaffey Irrigation schemes in Australia were based in Mildura, Victoria and Renmark, South Australia.
Address: Suburb/Nearest Town: Mildura & Renmark
State: Victoria & South Australia
Local Govt. Area: Mildura Rural City Council & Renmark Paringa Council
Owner: There are no specific owners identifiable as the towns, their, residents, the municipal councils and bodies of state governments are all stakeholders in the irrigation assets of the areas
Current Use: Both towns and their surrounding agricultural lands are primarily involved in irrigated farming of various products
Former Use: Little existed at the town sites prior to the first work on building irrigation systems in the late 1880s
Designers: George Chaffey (1848-1932), irrigation pioneer, engineer, inventor and entrepreneur, and William Benjamin Chaffey (1856-1926)
Maker/Builder: The Chaffey Brothers employed the local Irrigation Communities and external contractors to carry out some works
Year Started:

- Mildura: Indenture with Victorian Government signed May 1887
- Renmark: Agreement with South Australian Government,1887
- Mildura was certainly operational by December 1890 when the population of Mildura had reached 3300
- Renmark was certainly operational by December 1890 when the population of Mildura had reached 1100

Physical Description: Work followed a master plan laid out by the Chaffeys. Headworks consisted of pumping stations to lift water from the Murray River into channels at various levels to enable gravity delivery to each lot of agricultural land. The master plan also called for community infrastructure such as roads, schools, hospitals and many other community services. Some land levelling and grubbing of scrub from land was also carried out.
Physical Condition: The land remains in use for much the same purposes originally envisaged although crops may have changed in some cases to accommodate to available markets.

3·2 Historical Notes

Refer to the following chapters of 'Chaffey Brothers Irrigation Works in Australia' [3] which is reproduced in full at Appendix 2 of this nomination:

- Section 2 – Early life of Chaffey Brothers
- Section 3 - First steps towards irrigation in Mildura
- Section 4 - First steps towards irrigation in Renmark
- Section 5 - Engineering works at Mildura
- Section 6 - Engineering works at Renmark

3·3 Heritage Listings

Name: Psyche Bend Pumping Station
Status: Registered – Victorian Heritage Register
Number: H0548
Date: October 1983

Name: Billabong Pumping Station
Status: Registered – Victorian Heritage Register
Number: H0547
Date: October 1983

Name: Rio Vista
Status: Registered – Victorian Heritage Register
Number: H0729
Date: 3 May 1989

Name: Chaffey Mildura Pumping Scheme
Status: Registered – National Trust of Australia (Victoria)
Number: 68937
Date: not stated

[3] Peake Owen and Venus Richard, Chaffey Brothers Irrigation Works in Australia, 19thAustralasian Engineering Heritage Conference, Mildura 9-13 October 2017.

4 Assessment of Significance

4.1 Historical significance:

Refer to section 3.2 above.

4.2 Historic Individuals or Association:

Appendix 3 contains biographical details of the following key people in the Chaffed Story:

- George Chaffey
- William Benjamin Chaffey
- Alfred Deakin

4.3 Creative or Technical Achievement:

The Chaffey Brothers (and George in particular) showed considerable engineering judgment and innovation in the development of all of their irrigation schemes. The Technical achievements in relation to Mildura and Renmark are outlined in the following chapters of the paper 'Chaffey Brothers Irrigation Works in Australia' [4] which is reproduced in full at Appendix 2 of this nomination:

- Section 5 - Engineering works at Mildura
- Section 6 - Engineering works at Renmark
- Section 7 - Engineering Achievements
- Section 8 - Engineering Failures

4.4 Research Potential:

The Chaffey Brothers story is very well documented and there are few details which are not readily accessible.

However those researching the project will undoubtedly find areas where further research could be very useful. The crankshaft failures outlined in Section 7 of this nomination is a good example. It would be interesting to be able to come to a conclusion as to whether the George Chaffey design did contribute to the crankshaft failures or whether their design or manufacture in Tangyes was deficient in some way.

[4] Peake Owen and Venus Richard, Chaffey Brothers Irrigation Works in Australia, 19th Australasian Engineering Heritage Conference, Mildura 9-13 October 2017.

4·5 Social:

The social and cultural influences from the Chaffey story are quite broad-ranging both within the local communities where the Chaffey's worked and also much further afield in Australia.

Mildura and Renmark have become very successful communities. It is compelling to look back at the community model brought from the United States by the Chaffey's and compare that vision with the actuality of today well over a century later. The vision of fully rounded communities with everybody striving to put their effort into the overall success of the enterprise was quite sophisticated in the way it was implemented in the early days of the communities. Whilst the Chaffey's are long-gone much of that community cohesion and ferment remains. Driving through the towns today it is quite clear that they are prosperous, self-reliant, proud and innovative communities. In many subtle ways they tell us that they have succeeded in 'making the desert bloom' and that has built immense community pride.

These communities have also had impacts on other communities. All across the Murray Darling Basin (and beyond to some extent) there are 'river towns' which have made a success of growing one product or another based on irrigated agriculture. In one place it might be fresh fruit, in another dried fruit, in another vegetables and in another dairy cattle. They have all made their mark and the nation depends on them. To a great extent that tradition grew out of Mildura and Renmark.

Then there are the national changes which can be traced back to Mildura and Renmark. They were amongst the early advocates of using irrigated land to grow fruit from which 'dried fruit' is made. Packing dried fruit in children's lunch boxes is as Australian as Vegemite sandwiches. As a nation, we would be aghast at having to do without dried fruit. We have William Benjamin Chaffey to thank for that in large part.

William Benjamin Chaffey also believed that he could grow superior grapes in the irrigated desert soils with which to make wine. The 'river towns' have been very instrumental on placing wine on the dinner tables of many Australians. It might sound terribly un-Australian but we seem to be in the process of becoming wine drinkers as much as we are beer drinkers. We also have thank William Benjamin Chaffey for his part in that change.

4·6 Rarity:

The technologies which the Chaffey's introduced at Mildura and Renmark are now used through Australia and in fact all around the world. Those technologies have evolved and improved but the basics are still present. Today the channels of earlier days have given way to pipes and flood irrigation to drip feed irrigation but the technologies are still recognisable as fulfilling the same purpose.

In that respect most of the irrigation technology is not rare.

However there are some individual components which have some rarity. The George Chaffey triple expansion steam engines at Mildura were a portent of a trend in technology which put George Chaffey somewhat ahead of the pack in using marine steam engine technology (with which he was very familiar from his younger days on the Great Lakes) to

land-based use driving centrifugal pumps. In that respect the two triple expansion steam engines at Mildura are unique and of extreme heritage value.

4.7 Representativeness:

The Mildura and Renmark model of technical solution to aid irrigation has been followed in many places. Therefore most of it is representative of practice elsewhere in Australia and overseas.

4.8 Integrity/Intactness:

Overall integrity and intactness are quite high at Mildura and Renmark. Whilst many components have changed in the gradual modernisation of the industry and the more recent goals of increasing water use efficiency what remains is quite recognisable.

The fact that the two big triple expansion engines have survived, along with their respective pump houses is both remarkable and a credit to the people who have worked so hard to achieve that outcome.

4.9 Statement of Significance:

Several Statements of Significance have been found relating to this nomination. This listing starts with Statements of Significance from the Victorian Heritage Database (Heritage Victoria and National Trust listings) and ends with a Statement of Significance written specifically for this nomination:

4.9.1 Psyche Bend Pumping Station - Statement of Significance [5]

Last updated on - June 22, 1999

The various pumping stations were constructed by the Chaffey brothers as part of their vast irrigation scheme built after 1887. The brothers had come from North America, with the support of Alfred Deakin, where they had gained experience in California and around the great lakes.

The pumping stations were the beginning of an extensive system of irrigation channels. Psyche bend was the first, pumping the water out of the river. King's billabong was the main pumping station where four centrifugal pumps were capable of raising 32,000 gallons per minute together. The Ninety Foot and Nichol's Point pumping stations were further along the main channel and served most of surrounding land, the highest in the settlement. The Lock Nine Pumping Station is independent of the main system and was built later.

Several buildings at Psyche Bend have been demolished but the pump house remains intact with its engines. The design is very similar to the brick pump houses at Billabong and Nichol's Point where the engines have been removed. Nichol's Point has been substantially altered. The Lock Nine Pumping Station is the most complete with the original boiler

[5] Victorian Heritage Database, web site, http://vhd.heritagecouncil.vic.gov.au/places/845#sthash.gxS5Lohm.dpuf

surviving as well as the pumps and channelling. This building is constructed of corrugated iron. The pumping stations are considered to be of national significance for their historical associations and as examples of industrial architecture.

4.9.2 Billabong Pumping Station - Statement of Significance [6]

Last updated on - June 22, 1999

The various pumping stations were constructed by the Chaffey brothers as part of their vast irrigation scheme built after 1887. The brothers had come from North America, with the support of Alfred Deakin, where they had gained experience in California and around the great lakes.

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Several buildings at Psyche Bend have been demolished but the pump house remains intact with its engines. The design is very similar to the brick pump houses at Billabong and Nichol's Point where the engines have been removed. Nichol's point has been substantially altered. The Lock Nine Pumping Station is the most complete with the original boiler surviving as well as the pumps and channelling. This building is constructed of corrugated iron. The pumping stations are considered to be of national significance for their historical associations and as examples of industrial architecture.

4.9.3 Chaffey Mildura Pumping Scheme - Statement of Significance [7]

Last updated on - May 26, 2004

The vision of Alfred Deakin and the leglislation which he introduced enabled the development of the Mildura settlement and other major irrigation schemes on the Murray and Murrumbidgee River systems.

The work of George Chaffey enabled the establishment of a large population and extensive

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[6] Victorian Heritage Database, web site,
http://vhd.heritagecouncil.vic.gov.au/places/632#sthash.8PfqSq8Q.dpuf

[7] Victorian Heritage Database, web site,
http://vhd.heritagecouncil.vic.gov.au/places/68937#sthash.obvLqPmK.dpuf

industry in an arid area. The products of Sunraysia over the years, have contributed to the Australian export income, as well as supplying local markets.

The pumping plant in the Psyche Bend Pump house used a triple-expansion steam engine which was still the latest technology of the time. The pumps were the biggest in the world. The fact that four pumps were directly coupled to the crankshaft and engine was an innovation of world significance.

The creative thinking of George Chaffey was important and the application of mathematics, engineering science and the latest technology by Chaffey and other engineers of the period enabled such notable achievement to proceed.

Classified: 28/04/1986
Revised: 22/02/1988
See also B3577 Pump Houses, Psyche Bend, Nicholas Point & Loch Nine, B1643 Cannie Ridge Irrigation Pumps, B1390 Rio Vista & Billabong Primary School.

4.9.4 Rio Vista - Statement of Significance [8] [9]

Last updated on - June 28, 1999

Rio Vista and the former gardener's cottage at the rear at 199-205 Cureton Avenue, Mildura, have historical and architectural significance for the following reasons:

The significance of Rio Vista and the gardener's cottage at the rear can be assessed in terms of their architectural, historical and social importance at the regional, state and national levels.

The complex is of architectural importance as a very early example of the Queen Anne domestic style in Australia. It is preceded in Victoria by Woodlands, North Essendon, of 1888, to the design of Oakden, Addison and Kemp, but precedes the well documented work of Ussher and Kemp, William Beebe, Walter Butler, Christopher Cowper and others who practised in the Queen Anne manner during the post-1890's depression years. In this respect the architecture of Rio Vista was innovative in its day at the state and national levels, and remains distinctive for its use of decorative timberwork which relates directly to contemporary American practice. Rio vista is symbolic if the link with American architectural practice brought about by William Benjamin Chaffey's briefing of Mildura architect EC Sharland and by his importation of a Canadian joiner, W Kells. Although Canadian born, Chaffey had lived in California prior to his arrival in Australia and had first-hand experience

[8] Victorian Heritage Database, web site,
http://vhd.heritagecouncil.vic.gov.au/places/843#sthash.DzNCHr4z.dpuf

[9] Source: Report to the Minister.

of English Queen Anne domestic architecture as it had been interpreted for over a decade in America.

The design of the interior finishes is important at the state level for its use of local and imported timbers, stained and acid-etched glasswork of the Victorian period, and embossed wallpapers. The wallpapers are particularly intact, while the timber mouldings are noteworthy as sophisticated examples of Queen Anne mouldings and may be unique on account of their early date.

As the home of William Chaffey, Rio Vista attains historic significance for its links with the pioneering work of Chaffey Brothers Limited in establishing Australia's earliest irrigation colony on the Murray River.

The fabric of the building is important as a reflection of the constructional expertise available within the irrigation colony only two years after its founding in 1887. The joinery, being of local manufacture, is expressive also of the restrictions on importing mouldings from Adelaide and elsewhere, owing to the high cost of duties payable at colonial borders prior to federation.

The former gardener's cottage at the rear, which was probably built in 1889-90, is a two storied structure, strongly influenced by contemporary American Picturesque domestic architecture.

The landscaped grounds of Rio Vista are important as an example of the work of the prestigious local firm of Hughan and Glasson, trading as the Ontario Nursery.

4.10 Area of Significance:

The Mildura and Renmark irrigation system heritage is clearly of **State Significance** in Victoria and South Australia respectively.

The position of these two schemes, standing at the very beginning of the irrigation revolution in Australia gives these two sites, along with several other early irrigation schemes in Australia, **National Significance.**

International Significance comes from the overall influence of the Chaffey Brothers in both the United States and in Australia on the early development of sustainable and successful models for irrigation colonies.

5 Interpretation Plan

5·1 General Approach

The interpretation Plan will be carried out in accordance with the 2012 edition of the Guide to the Heritage Recognition Program which can be found on the EHA web site at www.engineeringheritage.com.au.

This will consist of interpretation developed in liaison with the owner (Mildura Rural City Council) and Engineering Heritage Victoria. The interpretation will be unveiled at a public ceremony probably in October 2017.

The ceremony should be held on **Friday October 13 2017.** The ceremony should be held Psyche Bend Pumping Station as a part of the 19th Australasian Engineering Heritage Conference.

A standard size 1200 mm wide by 600 mm high interpretation panel should be erected at one of three possible locations:

- Psyche Bend Pumping Station
- Billabong Pumping Engine located on the river bank in central Mildura
- In the vicinity of Rio Vista, the Chaffey house in central Mildura

5·2 The Interpretation Panel:

1 A title “Chaffey irrigation projects in Australia”.
2 Logos of Engineers Australia and Mildura Rural City Council to be incorporated.
3 A small scale representation of the EHA marker plate.
4 The ceremony date, award level and major stake holders names.
5 Text should be 24 point Arial Bold.
6 A map showing the location of the Chaffey irrigation projects.
7 Brief captions for each photograph.
8 Total text should not exceed 500 words excluding headings.
9 The panel to be constructed of vitreous enamel-on-steel plate or vinyl film on aluminium plate with flanges as per drawing at Appendix 6.
10 The panel to be mounted on a steel free-standing frame as per drawing at Appendix 6.
11 The EHA marker to be mounted below the interpretation panel as shown in Appendix 6.

5·3 Possible Interpretation themes for Interpretation Panel

The following subjects have been assessed as possible themes for the interpretation panel:

a) The history of the Chaffey Brothers irrigation works in Australia.
b) Engineering aspects of the Chaffey projects.
c) Brief Biographical material (including images) of the Chaffey Brothers and Alfred Deakin.

6 References:

Note that the bulk of references for this work are contained in the paper at Appendix 2.

Heritage Victoria / Heritage Council web site, http://heritagecouncil.vic.gov.au/heritage-protection/levels-of-protection/.

Peake Owen and Venus Richard, Chaffey Brothers Irrigation Works in Australia, 19th Australasian Engineering Heritage Conference, Mildura 9-13 October 2017.

7 Acknowledgments, Authorship and General Notes

7·1 Acknowledgments

I wish to acknowledge my colleague Richard Venus who co-authored the conference paper which forms the basis of this nomination. Richard is a long-time enthusiastic supporter of Engineering Heritage Australia (EHA). Richard is an electrical engineer and graphic designer of considerable professional standing. His study subjects have included several works associated with the Murray River.

I also wish to acknowledge the assistance of the Mildura Rural city Council in the arrangements for the 19th Australasian Engineering Heritage Conference and this heritage recognition process.

7·2 Nomination Preparation

This nomination was prepared by:

Owen Peake
FRMIT HonFIEAust CPEng
4 Islington Street
Collingwood Victoria 3066
Phone: +61 3 9419 0820 (home and work)
Email: owen.peake@bigpond.com

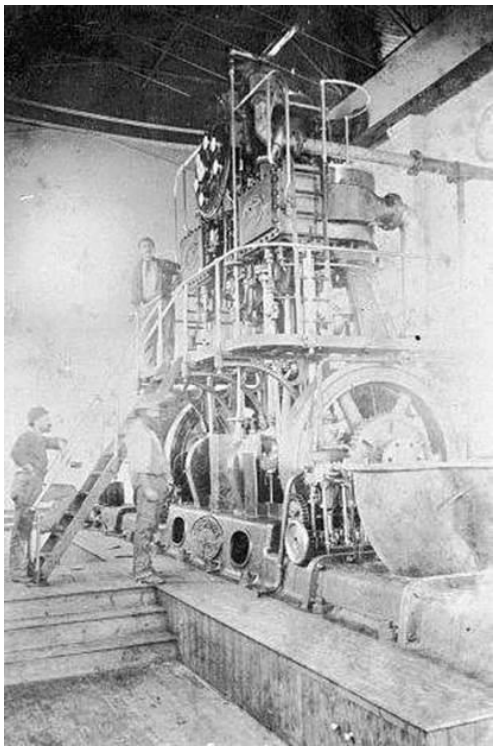
7·3 General Notes

This document has been prepared in accordance with the Commonwealth Government Style Manual for authors, editors and printers, Sixth Edition, revised by Snooks & Co, 2002.

The method of citation used in this document is the Vancouver System. See page 190 of the above Style Manual.

Appendix 1: Images with captions

Mildura Wharf in 1892. Whilst this facility was very rudimentary it connected Mildura to the world via the river paddle steamers. ***Image: source unknown.***

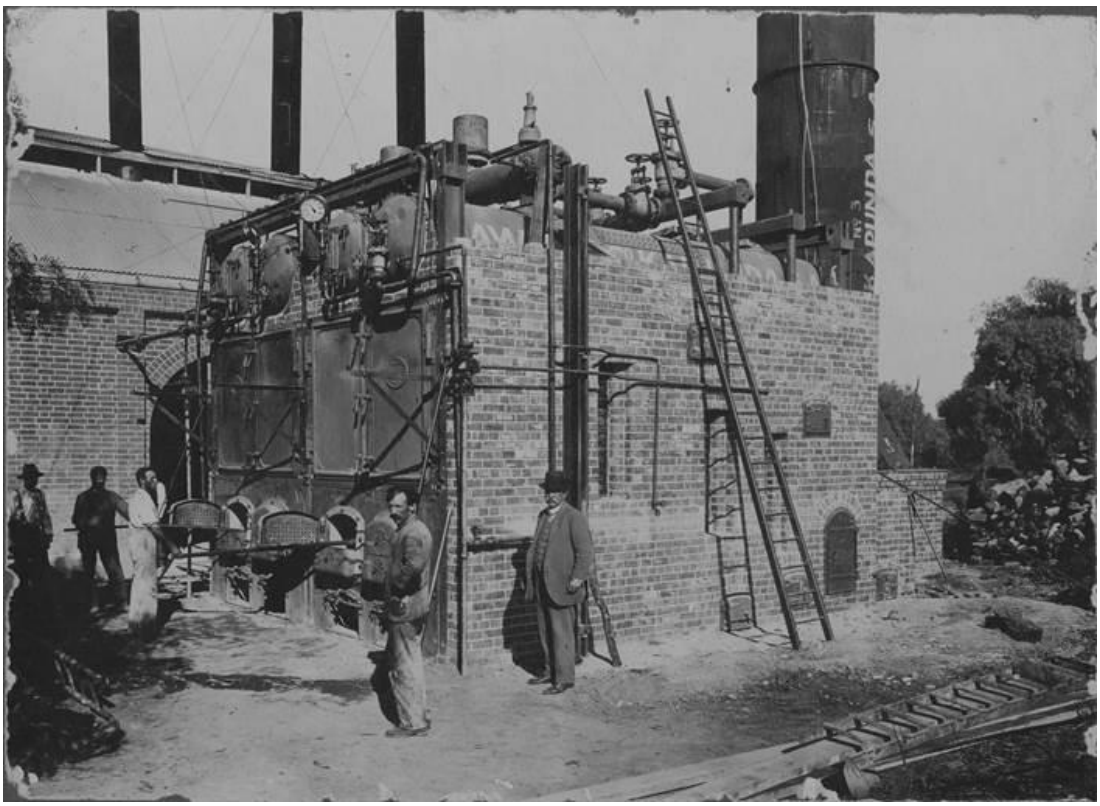


The Billabong Pumping Station pumping engine during erection.

Image: source unknown.

Rio Vista built by William Benjamin Chaffey in 1890 near the riverfront in Mildura. The house is now part of the Mildura Arts Centre.
Image: the Chaffey Trail.

Psyche Bend Pumping Station in 1915. The boiler house is in the foreground and the pumping station at right rear. Note the stack of timber for the boiler at left.
Image: The Chaffey Trail.

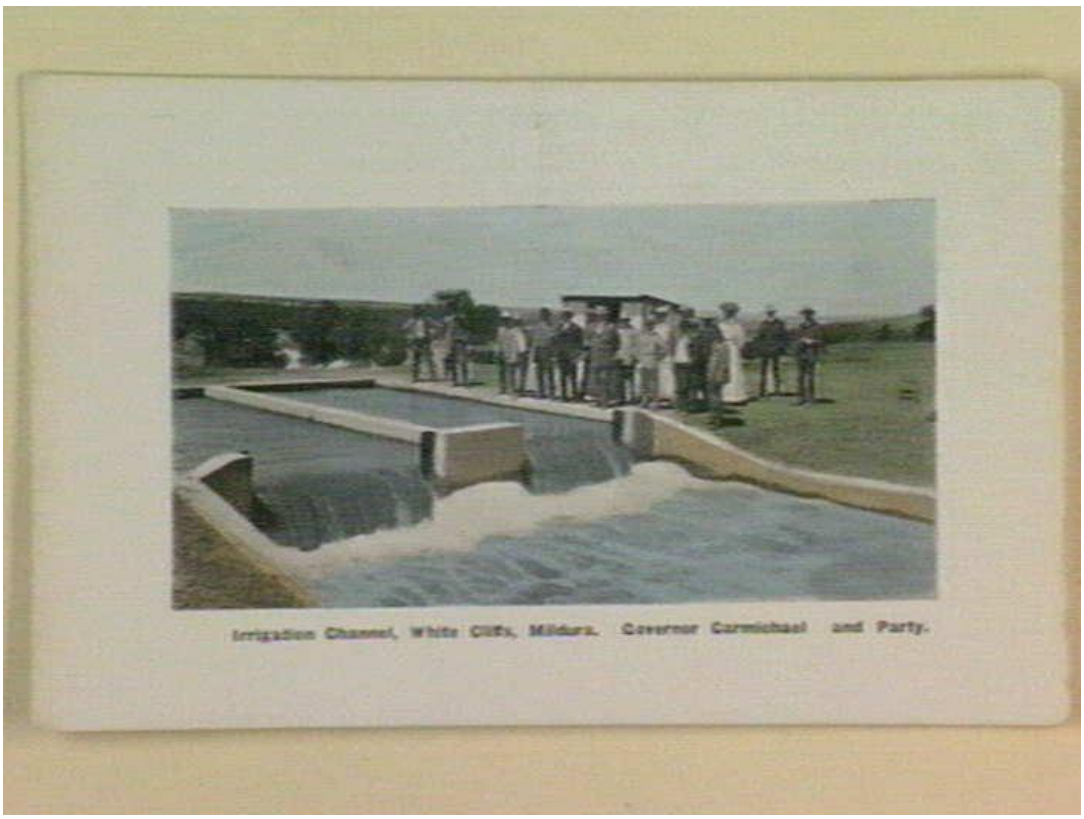


The Psyche Bend boiler in 1915. ***Image: source unknown.***

Fruit drying racks in the 1940s. ***Image: SLV.***

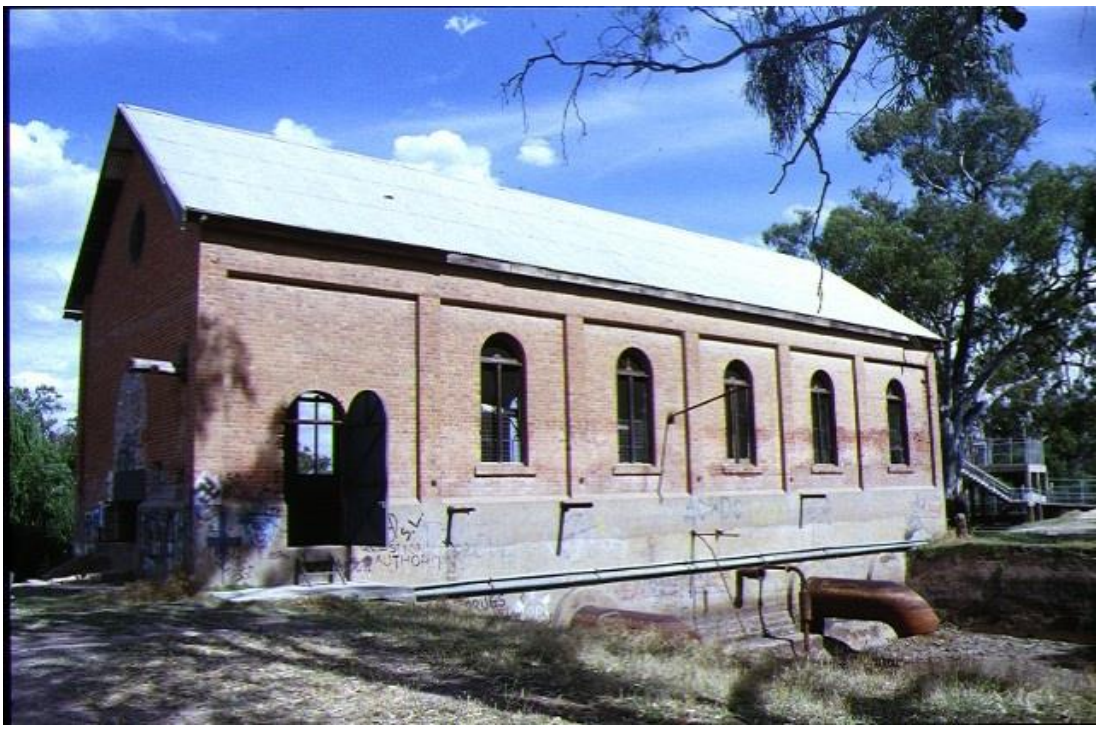
Mildura main street in 1948. ***Image: SLV.***

William Benjamin Chaffey statue, Mildura. ***Image: SLV.***

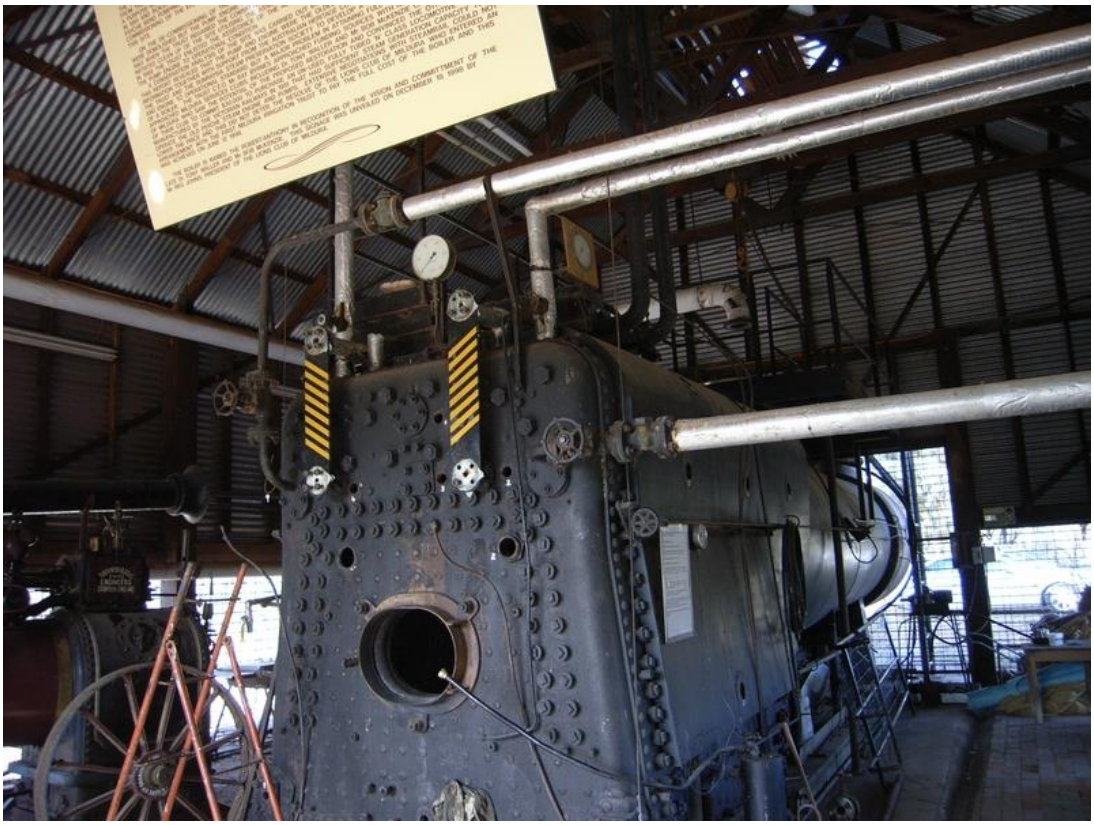


Inspecting irrigation channels at Red Cliffs, Governor Carmichael and Party. ***Image: SLV.***

Working on a channel, 1940s. ***Image: SLV.***

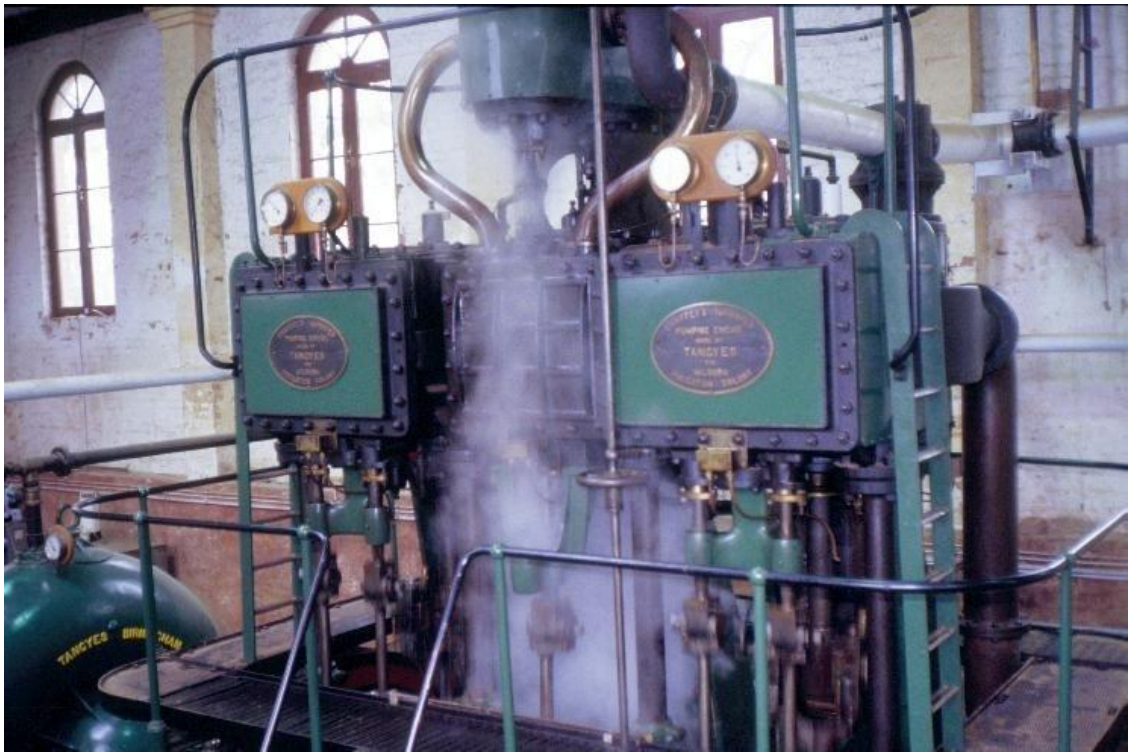


Psyche Bend Pumping Station. ***Image: Heritage Victoria, Victorian Heritage Database.***



Psyche Bend boiler. This is not the original boiler but a more recent ex-Victorian Railways locomotive boiler. ***Image: Heritage Victoria, Victorian Heritage Database.***

Psyche Bend pumping engine. Built by Tangye of Birmingham to the design of George Chaffey. Still running! ***Image: Peter Stone.***



Psyche Bend engine in steam. ***Image: Heritage Victoria, Victorian Heritage Database.***

Billabong Pumping Station. This station no longer contains pumping machinery but the engine, similar to that at Psyche Bend, is now on display in the centre of Mildura.
Image: Heritage Victoria, Victorian Heritage Database.

Appendix 2: Conference Paper – 'Chaffey Brothers Irrigation Works in Australia'

Document starts on following page

19th Australasian Engineering Heritage Conference
Mildura 9-13 October 2017

Chaffey Brothers Irrigation Works in Australia

Owen Peake FRMIT HonFIEAust CPEng
Engineering Heritage Australia, Melbourne, Victoria

Richard Venus MIEAust
Engineering Heritage Australia, Adelaide, South Australia

Abstract:

George and William Chaffey made significant contributions to the development of irrigation for agricultural land in dry climates with several successful project in California and at Mildura and Renmark in Australia.

Their combined skills allowed them to integrate engineering, social, commercial and agricultural techniques to develop irrigation colonies in very aggressive environments. Their work laid down principles which were followed by others enabling large scale irrigation projects which now contribute greatly to agricultural output in many arid and semi-arid parts of the world.

Engineer George Chaffey pushed the limits of the use of centrifugal pumps to achieve efficient, high volume pumping at an affordable cost for irrigation work. He also developed his skills to lay out efficient channel networks to distribute water over large areas with water delivered to the highest point of each block by gravity.

William pioneered the dried fruit industry and the wine-making industry at Mildura and helped to establish Australian excellence in those industries which continues to the present time.

The Chaffey colonies were, however, subject to serious disputation and public ridicule largely because of flaws in the financial models adopted for the colonies. This led to the establishment of Irrigation Trusts to operate, maintain and expand irrigation systems in return for rates from the landowners. This model proved to be more sustainable and brought stability and prosperity to irrigation areas.

The personal characteristic of the brothers are a model for all engineers. They were hard-working, not deterred by the many set-backs they encountered and they took breathtaking engineering and commercial risks in order to innovate. They combined a wide range of skill and high professional ethics in a way we should all admire.

1 Introduction

Early agriculture in Australia centred on the fertile valleys of the east and south coasts whilst grazing of sheep and cattle in the drier areas west of the Great Dividing Range followed close behind. It was not until the 1880s that attention turned to the development of irrigation schemes, primarily in the

Murray-Darling Basin. The first such projects were in the Goulburn Valley in Victoria and the Chaffey brothers projects in Mildura in Northern Victoria and Renmark in South Australia.

Whilst there were difficulties in getting early projects operating successfully the legendary persistence of Australian farmers prevailed. Australia now produces about 23% of its gross agricultural product from irrigated farms which together account for only 1% of all land used for agriculture and grazing in Australia [10]. The value of produce from irrigated farms reached A$13.4 billion in 2012/13 [11].

The Chaffey brothers George and William came to Australia in the late 1880s with considerable experience from developing irrigation colonies in California in the United States of America. They negotiated arrangements with both the South Australian and Victorian colonial governments and established successful irrigation colonies at Renmark and Mildura.

Others built on their work, the Murray in particular gradually acquired a high level of flow regulation from a series of weirs and locks and large storages were constructed to supply water over the annual cycles and through droughts. Water is now diverted from the eastern slopes of the Snowy Mountains via the Snowy Mountains Hydro-electric Scheme power stations to provide irrigation water along the long course of the Murray River.

This paper summarises the work of the Chaffey brothers and examines the engineering challenges they faced.

2 Early Life of Chaffey Brothers

"George Chaffey (1848-1932), irrigation pioneer, engineer, inventor and entrepreneur, and William Benjamin Chaffey (1856-1926), agriculturist and irrigation planner, were born on 28 January 1848 and 21 October 1856 respectively at Brockville, Ontario, Canada, sons of George Chaffey, a Canadian born at Zanesville, Ohio, United States of America, and his wife Anne, née Legoe, of Quebec" [12].

Both brothers developed a wide range of skills and possessed a strong entrepreneurial drive. They were tireless in whatever enterprises they were involved.

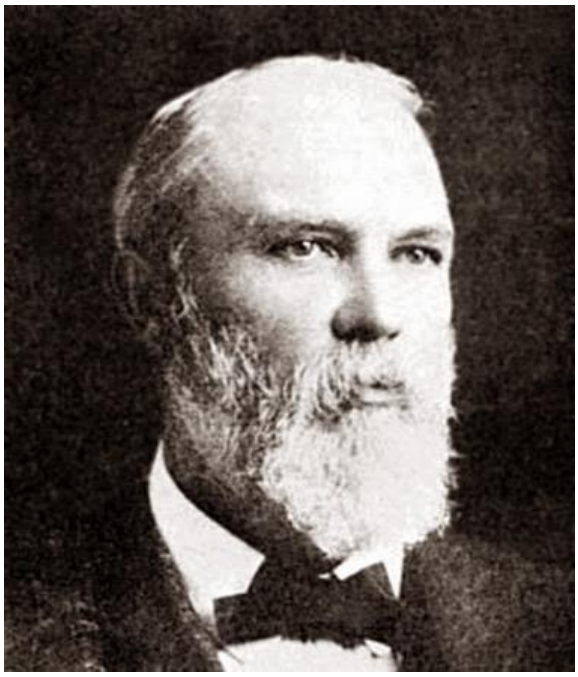
George Chaffey found many men willing to teach him in the workshops of his father's shipyard. He developed skills as a mariner. "Long before he was twenty he held a master's and engineer's ticket" [13].

It is said that at the age of 13, when his father was not available, he had taken one of his father's tugs to assist a ship in distress and had brought the ship safely to port [14]. After obtaining his maritime qualifications he was "given command of one of his father's tugs and later became master of a freighter trading between Chicago and Montreal [15]. His adventurous spirit led him to some risky undertakings. He nearly became involved in blockade running in the American Civil War but was physically restrained by his father. When he was 20, at his father's suggestion he went to work for his

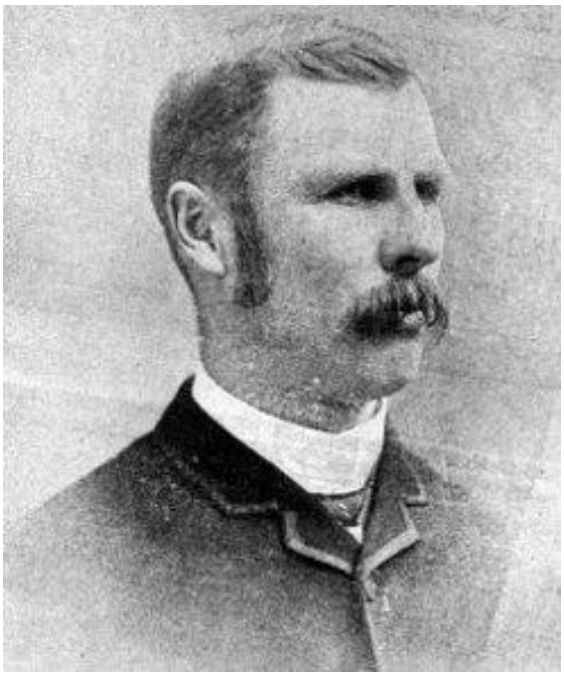
[10] Australian Bureau of Statistics, Drought drives down water consumption, Media Release, November 2006.
[11] Australian Bureau of Statistics, Water Account, Australia, 2012-13, retrieved 8 August 2015.
[12] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, National Centre of Biography, Australian National University, http://adb.anu.edu.au/biography/chaffey-george-5544/text9449, published first in hardcopy 1979, accessed online 19 December 2016. This article was first published in hardcopy in *Australian Dictionary of Biography*, Volume 7, Melbourne University Press, page 1 of online version, 1979.
[13] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 22, 1928.
[14] Ibid
[15] Ibid, page 23.

uncle Elswood in Toronto at the Etna Fire and Life Company. He stayed in Toronto for two years, "and returned to Kingston with a sound knowledge of office methods and with a wife" [16].

William Chaffey's early years are less certain but in 1878 his father moved to Riverside [17], near Los Angeles in the United States, to join other Canadian families at the Santa Ana River irrigation settlement [18]. William accompanied the family and George joined them later. The brothers made investments in new irrigation projects called Etiwanda and Ontario, on the Cucamonga Plain [19]. The irrigation settlements "were based on the purchase of land and water-rights by the Chaffey's at a low price, and resale to settlers in 10 acres (4 Ha) blocks, with a mutual irrigation company to distribute water on a non-profit basis" [20]. These developments were successful and provided a model which was later used at Mildura and Renmark.



George Chaffey.
Image: State Library of South Australia.



William Benjamin Chaffey.
Image: La Trobe Picture Collection, State Library of Victoria.

[16] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 23, 1928.

[17] 85 km west of Los Angeles.

[18] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, page 1 of online version, 1979.

[19] 53 km east of Los Angeles Downtown in the San Bernardino Valley.

[20] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, page 1,2 of online version, 1979.

3 First steps towards irrigation in Mildura

In 1877-84 northern Victoria suffered from drought, and Alfred Deakin, a minister in the Service-Berry government and chairman of a royal commission on water supply, visited the irrigation areas of California in 1885 [21]. This was intended to be a fact-finding mission but Deakin was so impressed by the skill and energy of the Chaffey Brothers, who he met at the beginning of his trip in Los Angeles that he was convinced to encourage the brothers to come to Victoria. George Chaffey arrived in Melbourne in February 1886 [22]. Chaffey inspected the Murray Valley and was "excited about its potential for irrigation" [23].

Chaffey selected what he considered to be suitable land of 250,000 acres at Mildura and made an agreement with the Victorian Government to spend at least £300,000 on permanent improvements over twenty years. A bill to validate the agreement was introduced into the Victorian Parliament but was violently opposed. It eventually passed through parliament but required the government to call tenders for the scheme which delayed the start of the project [24].

John Downer, Premier of South Australia, seized on the opportunity created by the Victorian government delay, travelled to Melbourne and offered the Chaffey Brothers a similar-sized block of land in the Renmark area of South Australia 133 km west of Mildura and also on the Murray River [25].

As no tenders were received by the Victorian government to counter the Chaffey offer the Chaffey's signed an indenture with Victoria in May 1887, giving them a total of 500,000 acres of land to develop for irrigation use. George concentrated on the required engineering works whilst William managed the settlement at Mildura and a younger brother, Charles came from California to manage Renmark. A huge amount of work was carried out over the next four years. By December 1890 the population of Mildura was 3300 and Renmark 1100, following an international sales promotion campaign [26].

Despite the largely successful technical aspects of the settlement at Mildura the Chaffey's had many detractors and the early days of the project proved arduous for the settlers. There were attacks on the Chaffey's in the Victorian parliament and the Melbourne newspapers ran a vitriolic campaign against the project [27]. This situation was intensified by the land boom collapse in the early 1890s in Melbourne, which is considered by the Reserve Bank of Australia to have caused a worse depression than the Great Depression of the 1930s [28].

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[21] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, page 2 of online version, 1979.

[22] Ibid.
[23] Ibid.
[24] Ibid.
[25] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, page 2 of online version, 1979.

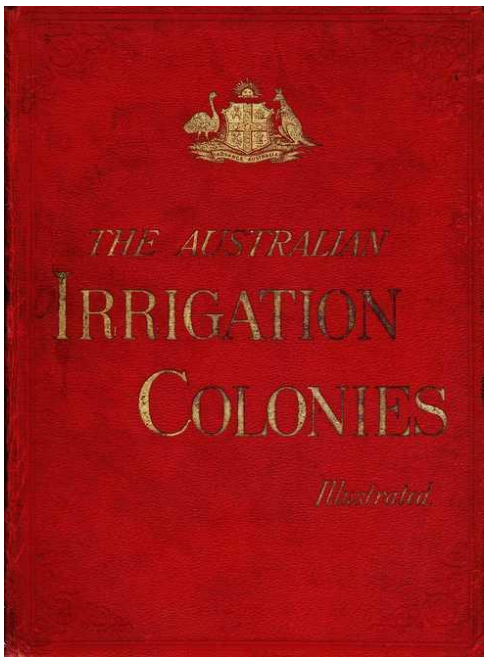
[26] Ibid.
[27] Ibid.
[28] Frost Andrew, Kew in the 1890s Depression, Kew Historical Society, paragraph 1, undated.

Taking levels for construction of irrigation channels at Mildura. ***Image: Victorian Places.***

The 90 foot Channel at Mildura. ***Image: Pictures Victoria.***

4 First steps towards irrigation in Renmark

“Avoiding political wrangling in Victoria, George Chaffey was attracted to Renmark and believed he could turn River Murray water onto the arid land and the region would flourish. In 1887 Chaffey signed an agreement with the South Australian government based on an incentive scheme, and Renmark effectively became the first irrigation settlement in Australia. The Chaffeys invested a fortune into preparing and irrigating blocks of land for sale. Many English settlers were attracted to the irrigation scheme in response to a 'Red' book published by the Chaffeys entitled *The Australian Irrigation Colonies*, promoting a bountiful future.



The Chaffey Brothers 'Red Book' which promoted the benefits of irrigation.
Image: State Library of South Australia.

But within six years the prospect looked bleak. The Chaffeys fell victim to the Bank Crash of 1893 and like many others, became almost penniless. In addition to this Depression, inexperienced settlers, inappropriate agricultural methods, unsuitable crop varieties, transport difficulties, fruit diseases and extremes of weather, all caused the company to fail. Many people literally fled their holdings.

In 1893 an Act of Parliament transferred the Chaffeys' rights to the Renmark Irrigation Trust, an elected body which provided the opportunity for settlers to manage their own resources. The Chaffey Brother's firm then ceased operations in 1895. George Chaffey returned to the United States, while William stayed on in Mildura and without any prospect of recovering his wealth, worked tirelessly to see the irrigation projects continue.

The principles of irrigation engineering are the legacy of the Chaffey Brothers' enterprise in Australia. Their innovation has had far reaching effects and pioneered the techniques that now allow for food to be grown year round in some of the driest settled land in Australia. Today, the River Murray sustains orchards, vineyards and vegetable crops, supported by canneries, wineries and food-processing factories" [29].

The land for the Chaffey enterprise at Renmark comprises "30,000 acres from the Bookmark Station lease was granted to the Chaffey's on which to build the new colony. Vineyards and fruit blocks slowly emerged throughout the district" [30].

Whilst George and William Benjamin Chaffey were fully occupied at Mildura who was running the enterprise at Renmark? "Charles Chaffey, a younger brother of George and W.B. Chaffey arrived in April 1888 and agreed to take over the Renmark operation. He selected land and gave plans for the building of his home to former Goolwa shipwright and carpenter A.F. Matulick. Charles returned to America and in October 1888 brought out his pregnant wife Ella and son. Ella remained in Adelaide to give birth to their second son and in January 1889 the family and servants travelled by the PS *Corowa* to Paringa. Here they resided in the Paringa Station Homestead situated on a hill close by the Paringa Bridge today, until they moved into their new home in the last months of 1889.

[29] State Library of South Australia, Irrigation and exploitation: Chaffey Brothers, web site, www.samemory.sa.gov.au/site/page.cfm?u=1367.
[30] Renmark Paringa Council web site, history, www.renmarkparinga.sa.gov.au/history.

Charles Chaffey chose a Canadian log-cabin style for his home; the walls of Murray pine logs had been laid horizontally supported by vertical pine posts slotted to receive them with deep shady verandahs added later. The kitchen was separated from the main house by a breezeway.

The inside of the house was lined an sealed with lath and plaster and has wooden floors. There were also numerous cellars only one being still in use. "Olivewood" was classified by the National Trust of SA and is on the State Heritage List as well as the Commonwealth List.

The original selection had an extensive olive grove planted in 1890 (with complete building and olive mill processing olive oil), and lemon and orange orchards including the first naval orange tree brought to Australia and later on grapefruit. there were vineyards and zante currants and muscat grapes and orchards of peaches, apricots and pears. Then there were fields of wheat, alfalfa and lucerne for stock - the "Olivewood" dairy was a noted one - and windbreaks of eucalyptus to protect crops from wind and dust storms.

The family consisted of 6 children : George (1886 California), Charles (1888), Margaret (1889), Francis (1891), Harriet (1892) and Olive (1900). The home was run with the help of a cook, housemaid and a very competent governess; when the children were old enough they attended boarding school in Adelaide.

Ella Chaffey was an authoress of children's books. In 1896 *The Youngsters of Murray Home* was published and was based on here own children's lives at "Olivewood". The newspaper reviews of the day compared her favourably to the popular Ethel Turner.

The Chaffeys were well respected and involved in all aspects of the new settlement. In 1904 the family left to visit British Columbia, Canada and in their absence the mortgage over "Olivewood" was foreclosed due to crop failure. Household furnishings and personal property was sold by public auction. The furniture in the house, at present, has been provided by the National Trust of SA, as well as gifts from local people [31].

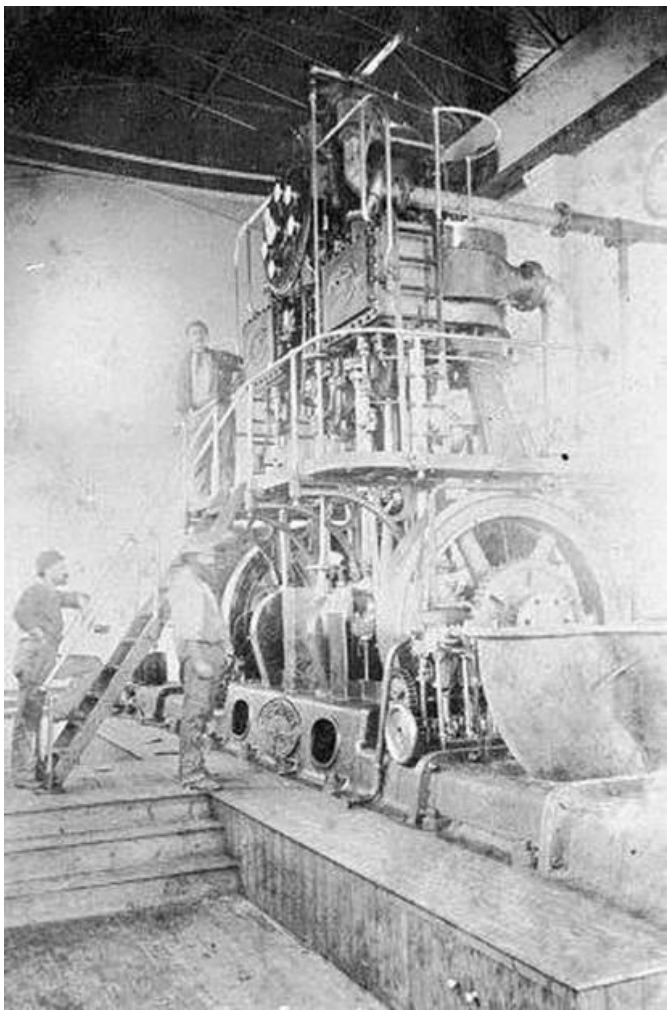
5 Engineering works at Mildura

George Chaffey was faced with a significant engineering challenge at Mildura. He knew that the red soil of the Mallee would be highly productive if enough water was available and at Mildura the Mallee soils came up to the river bank. However the river bank in the area was approaching 90 feet (27 m) above summer river level whilst the land sloped gently away from the river towards the south. The maximum reliable lift of centrifugal pumps of the era was about 35 feet (11 m) meaning that pumping would have to be done in several stages [32].

Chaffey selected King's Billabong to be developed as a storage reservoir for the scheme and the first lift from the river to the irrigation channels above. King's Billabong would be dammed at each end to provide a storage about 20 feet (6 m) above summer river level [33].

[31] Discover Murray – Australia's Greatest River, Olivewood, Renmark – built for Chaffey Bros irrigation in 1889, www.murrayriver.com.au/renmark/olivewood.

[32] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 160, 1928.
[33] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 160, 1928.



The Psyche Bend steam pumping engine being erected.
Image: source unknown.

The Psyche Bend pumping engine. Still running on steam 130 years after it was commissioned. *Image: Peter Stone.*

To raise water from the river to King's Billabong Chaffey designed a large triple expansion steam engine with a maximum power of 1000 IHP [34] to be located at a place called Psyche Bend on the south bank of the Murray River about 7 miles (11 km) upstream from the centre of Mildura. The pumps required to deliver a peak output of 150,000 gallons per minute (2 ML/s) and the engine was configured to drive two 40 inch (1 m) diameter pumps at each end of the crankshaft driven at engine speed directly connected to the crankshaft. The engine would run at 160 revolutions per minute and use a steam pressure of 140 pounds per square inch (965 kPa) [35]. "For the first time in engineering history, direct-acting triple expansion engines were to be used for driving centrifugal pumps" [36].

A second pumping station called Billabong was constructed to pump from King's Billabong to the 50 foot (15 m) channel. The engine in this station was identical to the Psyche Bend engine however the four pumps were of 20 inch (508 mm) diameter and delivered 40,000 gallons per minute (528 kL/s).

[34] IHP = Indicated Horsepower, the measured output of a steam engine.
[35] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, pages 164/5, 1928.

[36] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 165, 1928.

The delivery head of Billabong pumping station varied between about 30 to 35 feet (9.2 m to 10.7 m) depending on the water level in King's Billabong [37].

The construction of these engines was entrusted to Tangyes Limited of Birmingham, England. The company might have had some concerns about the Chaffey design as the names plates read "Chaffey's Improved Pumping Engine Made by Tangyes for Mildura Irrigation Colony" suggesting some attempt to minimise their liability. The design of the engines caused a storm in Australian and English engineering circles at the time. However Chaffey was vindicated by the long life of the engines. The Psyche Bend engine is still in operation and is demonstrated working on steam and pumping water periodically [38]. The King's Billabong engine has been preserved and is now located in a park in central Mildura.

George Chaffey designed the channel system at Mildura with the objective of providing water at the highest point on every block of land by gravity from an irrigation channel. By 1893 there were four systems in operation serving a total of 29,950 acres (12,130 ha). The systems were: Billabong system, 26,020 acres (10,538 ha); Homestead system, 1630 acres (660 ha); Ranfurly system, 450 acres (182 ha) and Town system, 1850 acres (749 ha) [39]. The channel systems were at various elevations however the principal channels in the larger Billabong system were at the 50 foot (15 m), 70 foot (21 m) and 75 foot (23 m) elevations above summer river level. This required a total of 10 pumping stations (including the two large stations at Psyche Bend and Billabong, already discussed). All these stations were steam powered and various manufacturers supplied engines and pumping plant including W H Allan, Sons & Co of Bedford [40]; Tangyes Limited of Birmingham [41] and Blake [42]. All the pumping engines drove centrifugal pumps except the Blake engines which drove duplex plunger pumps [43].

With pumping stations and the channel system in place and the township of Mildura established and thriving the future of the Chaffey project and the Mildura community appeared secure. The fortunes of the project and community would change in the mid-1890s when "internal dissensions brought the growth of the colony to a standstill" [44].

6 Engineering works at Renmark

Little has been discovered about the engineering side at Renmark. It is clear that it was on a much smaller scale than Mildura and that it followed similar principles. Steam pumping from the river was employed and a steam engine and centrifugal pump is mounted outside the Irrigation Trust Office in Murray Street, Renmark.

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[37] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 165 footnote, 1928.
[38] Peake Owen, Chaffey Irrigation Pumping Engines at Mildura, International Stationary Steam Engine Society, Bulletin IB30.4, pp 23-29, summer 2005.
[39] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 166, 1928.
[40] Grace's Guide uses this company name at the time when the Mildura plant was manufactured.
[41] Ibid.
[42] The name of Blake as referred to by Alexander J A is not found in Watkins George, Stationary Steam Engine Makers, Volume 1, Landmark Publishing Limited, contents page 5, 2006.
[43] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 166 including footnote, 1928.

[44] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 173, 1928.

Tangye, Birmingham steam pumping engine at the Renmark Irrigation Trust Office.
Image: Owen Peake.

This engine is considerably smaller than the two triple expansion engines at Mildura and of a more conventional Tangye design being a compound design (steam is used twice in each cycle).

The image below shows workers preparing an irrigation channel by hand. Very little machinery would have been used on this kind of project in the late 19th century era. This channel seems to be very similar in construction to the channels at Mildura. The inside of the channel is not lined which proved to be a weakness at Mildura and probably also at Renmark.

Building an irrigation channel at Renmark. Note that the heaviest earthmoving appliance in the image is a shovel. ***Image: State Library of South Australia, Catalogue number B53443.***

7 Engineering Achievements

George Chaffey showed considerable bravery in much of his engineering design and repeatedly pushed the boundaries of engineering practice of the day to achieve his objectives. Furthermore he carried out much of his engineering design away from the engineering resources of large cities whilst working in the wilderness.

His adoption of marine-type triple expansion steam engines to drive the pumps at Psyche Bend and Billabong is an example. He adopted an unusual cylinder configuration with a three-crank engine with the high pressure and intermediate pressure cylinders driving the centre crank and the two low pressure cylinders driving the outer cranks. The configuration, whilst mechanically symmetrical places a larger load on the centre crank than out the outer cranks [45]. Many engineers of the day regarded this as grossly bad practice and said so loudly [46].

Steam engines, relying on many features developed in marine practice, became the standard configuration for pumping engine in the years after the Chaffey engines were built and remained the best available technology until reticulated electricity saw a change to electric pumping plant.

Whilst it is true that, in the long career of the two identical engines, the Psyche Bend engine suffered two crankshaft breakages we need to look carefully at the circumstances before jumping to the conclusion that Chaffey had erred in his design. The engine was commissioned in 1891 and the first crankshaft breakage occurred in 1902 after 11 years of service. The second crankshaft did not actually fail but showed cracking in 1932, was strapped and the replacement crankshaft was fitted in 1934. The third crankshaft was not supplied by Tangyes Ltd but was forged in Australia by the Commonwealth Steel Co Ltd at Port Waratah in New South Wales and machined by Robison Brothers in Melbourne, Victoria [47]. This crankshaft has now been in service for 82 years and has outlived its two predecessors combined by some 39 years and is still in service [48]. So the question remains: were the two Tangye crankshafts in some way deficient in design or manufacture or was the Australian replacement crankshaft different in some details of design or manufacture? Whatever we may now conclude it would be brave to suggest that Chaffey's original design was faulty given the duty which the engine performed.

Whilst the Tangyes Ltd engines were being manufactured and shipped to Australia George Chaffey devised a clever way to provide water for irrigation in the short term. "He purchased an old river boat, the *Jane Eliza,* and converted her into a pumping barge, fitted with two 20-inch centrifugal pumps. This kept King's Billabong full in the early days of Mildura, and thus the *Jane Eliza* advanced the Mildura irrigation era by nearly two years" [49].

George Chaffey had a particular skill for the efficient layout of irrigation channels. He had developed this skill in California and is known to have used it at Mildura. "A few days driving through the scrub

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[45] Approximately 75% of the engine's horsepower was generated on the centre crank with the outer cranks accounting for approximately 12.5% of the horsepower each.
[46] Engineering Magazine, London, Letters to the Editor, 18 January 1889.
[47] Peake Owen, Chaffey Irrigation Pumping Engines at Mildura, International Stationary Steam Engine Society, Bulletin IB30.4, pp 26-27, summer 2005.

[48] The authors concede that the engine has been in semi-retirement for much of the 82 year life of its third crankshaft however it was in active irrigation service for 25 years after the Australian crankshaft was fitted. In 1959 the pumping duty was taken over by electrically driven pumps.
[49] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 162, 1928.

and George Chaffey had, with the wave of his hand, as it were, marked out the main lines of reticulation. Later the surveyor and his party found the level and fixed the channel lines almost exactly as the master mind had first visualized (sic) them" [50].

8 Engineering Failures

The only engineering failure of significance that can be found in the record of the Chaffey projects relates to the high level of seepage through the walls of the channels. As initially constructed the channels were excavated through the sandy soil of the area and their inner surfaces were simply compacted before placing them into service. "The defects of the channels are due to the porosity of the soil, to the imperfect consolidation of some portions of the built banks, and the burrowing of crayfish" [51] [52] [53] [54].

9 Outcomes at Mildura

By the early 1890s the Chaffey brothers and their companies were besieged by problems. As outlined in section 3 above there were concerted political attacks on them. "The irreconcilable minority" [55] amongst the settlers at Mildura were making unrealistic demands on the Chaffey's and the Victorian Government. Furthermore it became clear that the Chaffey companies were under capitalised and this led to a lack of maintenance of existing plant and a cessation of any further developments.

In August 1893 Stuart Murray, Chief Engineer for Water Supply [56], was instructed to report on the complaints against Chaffey Brothers Ltd. He found that some were justified, and, largely on his recommendation, the Mildura Irrigation Trust was set up in September 1895 to take over the functions of the Mildura Irrigation Co. George had visited London in 1894 in a desperate effort to save his firm by selling the ailing Renmark concession, but failed to raise any money. On 10 December [1894] Chaffey Brothers Ltd went into liquidation, owing £22,000 in wages to its employees and with assets of some 438,000 acres (177,254 ha) of unsold land at Mildura and Renmark. The Bank of Victoria foreclosed on the mortgages of hundreds of settlers, but eventually the irrigation colonies at Mildura and Renmark grew to prosperity with assistance from the relevant governments" [57].

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[50] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 160, 1928.

[51] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 223, 1928.

[52] The crayfish most likely to cause damage to irrigation channels is the Common Yabby, Cherax destructor or the Murray Crayfish, Euastacus armatus. Both species are freshwater crustaceans. The Yabby is found widely in Australia but is most common in Victoria and New South Wales whilst the Murray Crayfish is found primarily in the Murray and Murrumbidgee Rivers and their tributaries. Both species are edible. The Yabby is edible but for country children 'catching Yabbies' is more play than a genuine bush tucker pursuit to feed the family.
[53] Common Yabby, Wikipedia, last updated 3 December 2016, downloaded 21 December 2016.
[54] Murray crayfish, Wikipedia, last updated 30 November 2016, downloaded 23 December 2016.

[55] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 222, 1928.

[56] Alexander J A, The Life of George Chaffey, Macmillan & Co Ltd, Melbourne, page 168, 1928.

[57] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, page 3 of online version, 1979.

Mildura thriving. Corner of 8th Street and Longtree Avenue, 1948.
Image: State Rivers and Water Supply Commission, Victoria.

Mildura Irrigation Area from low earth orbit with pumping stations and the centre of Mildura City marked. This image covers an east-west distance of 34 km. ***Image: Google Earth.***

In 1896 (Sir) George Turner's administration appointed a royal commission to inquire into the Mildura settlement and make recommendations for its future. The Chaffey brothers and Deakin were subjected to long questioning, and the commission's report, tabled on 2 August 1897, largely blamed the Chaffeys for the troubles at Mildura, claiming that they had operated on insufficient capital and committed serious errors in planning" [58].

In August 1897 George sailed to the United States where he plunged into subdivision ventures before returning to irrigation projects. He tapped underground water to revive the Ontario settlement, diverted the waters of the Colorado River to irrigate the desert which he renamed Imperial Valley, and developed new colonies near Los Angeles. Finally he formed a banking partnership with his son Andrew, involving much travel in the United States and Canada. He died at Ontario, California on 1 March 1932. Extremely vigorous in both body and mind, George was a figure of Pacific importance, described by a friend as 'limited only by his excesses'. No responsible person doubted his complete integrity, despite his astonishing variety of enterprises and the fact that some of the men closely associated with him later acquired reputations for very doubtful financial practices. In particular Deakin spoke of him frequently as a great pioneer in Australian agriculture and a valued personal friend [59].

10 Outcomes at Renmark

The causes of the early failure of the Chaffey schemes were largely external and hence the outcome at Renmark was much the same as at Mildura. Chaffey Brothers Ltd failed, government sponsored Irrigation Trusts took over the responsibilities for operating the infrastructure of the systems and it took many years to find stability and prosperity.

[58] Peter Westcott, Chaffey George (1848–1932), Australian Dictionary of Biography, page 3 of online version, 1979.

[59] Ibid.

Renmark Hotel and park along Murray River in recent times. Another prosperous river town built on irrigation. ***Image: Renmark Hotel.***

Renmark Irrigation Area from low earth orbit with the centre of Renmark marked. This image covers an east-west distance of 34 km. ***Image: Google Earth.***

11 Legacy

The Chaffey Brothers left behind them at Mildura and Renmark irrigation systems which established the possibility of intense agriculture in semi-arid environments on a large scale by the use of modern technology and innovation.

After financial failure of the Chaffey projects in the 1890s commercial and operational models which were more sustainable evolved, and continue to evolve to this day.

Technically the greatest advance since the Chaffey era is the control of river levels in the Murray River by the installation of weirs and locks along the river facilitating the drawing of water from the river by providing relatively consistent and predictable river levels. Furthermore the storage of large quantities of water in major storage dams in the upper reaches of the river system has largely mitigated the problem of annual variation in rainfall and runoff.

The development of irrigated agriculture in Australia was critical to the nation, not only feeding itself in the driest continent, but also being able to export large quantities of agricultural product to world markets.

The Chaffey brothers made a huge contribution to the development of irrigated agriculture in Australia. However many others also contributed in other regions and in other ways to develop the industry we see today. The work is by no means over as we continue to struggle with balancing the various pressures relating to river health, irrigated agriculture and all the related environmental, social and economic factors.

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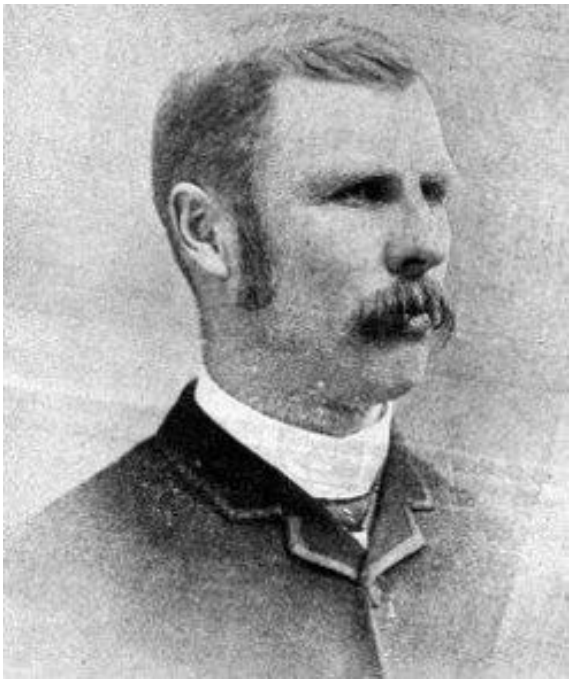
Appendix 3: Historic Individuals or Associations

Chaffey, George (1848-1932)

Chaffey, William Benjamin (1856-1926) [60]

George Chaffey.
Image: www.ontarioca.com.



William Benjamin Chaffey.
Image: La Trobe Picture Collection, SLV.

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George Chaffey (1848-1932), irrigation pioneer, engineer, inventor and entrepreneur, and William Benjamin Chaffey (1856-1926), agriculturist and irrigation planner, were born on 28 January 1848 and 21 October 1856 at Brockville, Ontario, Canada, sons of George Chaffey, a Canadian born at Zanesville, Ohio, United States of America, and his wife Anne, née Legoe, of Quebec. In 1859 the family moved to Kingston on Lake Ontario. George attended Kingston Grammar School. He seems to have been in poor health, and was certainly

[60] Westcott Peter, Australian Dictionary of Biography, Volume 7, Melbourne University Press, 1979, accessed online 13 February 2017.

uninterested in classroom instruction. But even at that early age he keenly sought out engineering books at the local library. He left school at 13, and soon became fascinated by the machinery in his father's shipbuilding yard and in the Lakes steamers. In May 1862 he was apprenticed as a marine engineer on Lake Ontario. Although entirely self-instructed, he obtained a United States certificate at 18, but in 1867 went to work in his uncle Benjamin's bank in Toronto. On 21 May 1869 he married Annette, only child of Thomas McCord, city chamberlain. In 1870-80 George was a partner in his father's shipyard, achieving a deserved reputation as designer and builder of shallow-draught steamers for the Great Lakes and the Ohio and Frazer rivers in British Columbia. During this period his three sons, Andrew, Benjamin and John, were born.

In 1878 George Chaffey senior moved to Riverside, near Los Angeles, California, to join other Canadian families in the Santa Ana River irrigation settlement. William Benjamin, who had been in his employment at Kingston, accompanied him. Their reports induced George junior to join them, since he had grown into a restless entrepreneur. The large profits that flowed from the Riverside venture encouraged George and William to become partners in the new irrigation colonies, named by them Etiwanda and Ontario, on the Cucamonga Plain. These settlements were based upon the purchase of land and water-rights by the Chaffeys at a low price, and resale to settlers in 10-acre (4 ha) blocks, with a mutual irrigation company to distribute water on a non-profit basis. Much of the success of irrigation at Etiwanda and Ontario was due to the use of cement pipes in the main water channels. Planned towns, social institutes and prohibition were features of both colonies, which were regarded as model settlements throughout western America. In addition to his vigorous and innovatory irrigation schemes, George became interested in electric lighting. He was president and joint engineer of the Los Angeles Electric Co., which gave to that city the most extensive lighting by electricity in the United States at the time. He also set up the first trunk line telephones in California.

In 1877-84 northern Victoria suffered from drought, and Alfred Deakin, a minister in the Service-Berry government and chairman of a royal commission on water supply, visited the irrigation areas of California in 1885. He met George and William Chaffey, admired their skill and energy and discussed the possibilities of irrigation in Victoria. Deakin's progress report, the dispatches of two journalists, (Sir) Edward Cunningham and J. L. Dow, who travelled with him, and the exaggerated tales of Stephen Cureton, a new-comer in Los Angeles, who had travelled in Australia, combined to tempt George to Melbourne, where he arrived in February 1886. Despite the later allegations of his political enemies, Deakin certainly never invited him to Victoria. At this juncture George's strong entrepreneurial instincts gravely affected his business judgment. He was plainly warned by Deakin and officials of the Water Supply Department that he would have little chance of obtaining a land grant on terms similar to those in California, but failed to understand the extent to which the Australian national outlook had diverged from the Anglo-American pattern of economic individualism. He was persuaded to look at the Murray Valley and returned to Melbourne excited about its potential for irrigation. Without fully realizing the import of his offer, Deakin assured George that the government would make available 250,000 acres (101,172 ha) of crown land on favourable terms. In April George somewhat rashly cabled his brother William to sell their Californian interests, which he did at a fraction of their real worth and then hurried to Victoria.

George returned to the Murray and selected a derelict sheep station at Mildura as the site for his first irrigation settlement. It was in the Mallee, described in a famous phrase as 'hissing desert', and 163 miles (262 km) from the nearest railhead at Swan Hill. But the Chaffey brothers signed an agreement with the Victorian government on 21 October, committing themselves to spend at least £300,000 on permanent improvements at Mildura in the next twenty years. A bill to validate this agreement, introduced into the Legislative Assembly by Deakin on 30 November, was violently opposed, the Chaffeys being termed 'cute Yankee

land grabbers'. The disposal of crown lands was a sensitive issue, and some of the Chaffeys' associates and salesmen were indeed deficient in truth and honesty. An amendment inviting tenders for the 250,000 acres at Mildura was passed. Meanwhile (Sir) John Downer, premier of South Australia, journeyed to Melbourne and offered a suitable block of 250,000 acres in his colony. The two brothers acted with their usual alacrity and selected river frontages in the Renmark area.

Since no tenders were received, the Chaffeys decided to go ahead at Mildura also. On 31 May 1887 they signed an indenture with the colony of Victoria, but in September transferred all their rights under it to the firm of Chaffey Brothers Ltd; twelve months later J. F. Levien replaced Cureton as a director, taking responsibility for the company's finances. With 500,000 acres (202,345 ha) of desert to develop, George showed astonishing energy and initiative in the next four years. William remained at Mildura, and a younger brother Charles came from California to manage the Renmark area. An expensive sales promotion campaign was initiated in Australia and Britain and, despite extreme difficulties of transport, 3300 people were at Mildura by December 1890 as well as 1100 at Renmark — about half of them new British migrants. The towns were well laid out and street trees planted lavishly in the style of Chaffey's American settlements. Difficulties and disputes abounded, but while revenue from land sales flowed in the Chaffeys remained confident. However, dissatisfaction among the settlers because of the loss of water from seepage was accentuated when B. C. Harriman, who had served in the Crown Law Department, told them that the operations of the Mildura Irrigation Co. were illegal and that the subdivisions were entitled to free water. Attacks on the Chaffeys' practices were carried to the Victorian parliament. A storm broke over their heads, intensified by the collapse of the land boom in Melbourne and a drift away from Mildura. City newspapers magnified the troubles at Mildura into a public scandal. Ministerial reports and a select committee failed to offer a solution. The radical elements among the settlers were determined to get rid of the Chaffeys and substitute government control.

In August 1893 Stuart Murray was instructed to report on the complaints against Chaffey Brothers Ltd. He found that some were justified, and, largely on his recommendation, the Mildura Irrigation Trust was set up in September 1895 to take over the functions of the Mildura Irrigation Co. George had visited London in 1894 in a desperate effort to save his firm by selling the ailing Renmark concession, but failed to raise any money. On 10 December Chaffey Brothers Ltd went into liquidation, owing £22,000 in wages to its employees and with assets of some 438,000 acres (177,254 ha) of unsold land at Mildura and Renmark. The Bank of Victoria foreclosed on the mortgages of hundreds of settlers, but eventually the irrigation colonies at Mildura and Renmark grew to prosperity with assistance from the relevant governments.

In 1896 (Sir) George Turner's administration appointed a royal commission to inquire into the Mildura settlement and make recommendations for its future. The Chaffey brothers and Deakin were subjected to long questioning, and the commission's report, tabled on 2 August 1897, largely blamed the Chaffeys for the troubles at Mildura, claiming that they had operated on insufficient capital and committed serious errors in planning.

In August 1897 George sailed to the United States where he plunged into subdivision ventures before returning to irrigation projects. He tapped underground water to revive the Ontario settlement, diverted the waters of the Colorado River to irrigate the desert which he renamed Imperial Valley, and developed new colonies near Los Angeles. Finally he formed a banking partnership with his son Andrew, involving much travel in the United States and Canada. He died at Ontario, California on 1 March 1932. Extremely vigorous in both body and mind, George was a figure of Pacific importance, described by a friend as 'limited only by his excesses'. No responsible person doubted his complete integrity, despite his astonishing variety of enterprises and the fact that some of the men closely associated with him later acquired reputations for very doubtful financial practices. In particular Deakin spoke

of him frequently as a great pioneer in Australian agriculture and a valued personal friend. Chaffey's son Ben (1876-1937) had stayed in Australia, building up business interests in Mildura before becoming a prominent Riverina pastoralist and well-known racehorse owner.

William Benjamin Chaffey also remained in Mildura to 'see it through'. He worked long hours to bring his orchard of some 200 acres (81 ha) into production and established the Mildura (later Mildara) Winery Pty Ltd which in 1914 moved its headquarters to Merbein. Active from 1895 in the development of marketing procedures for local fruit, he became a leading member of both the Mildura and the Australian Dried Fruits associations and was president of the latter for many years. In 1903 he was elected president of the Mildura Shire Council and in 1920 first mayor of Mildura Borough. Known affectionately as 'The Boss' or W.B., he was president of the Old Pioneers' Association and of the local horticultural and agricultural society, and was an active Freemason. In December 1911 the residents of Mildura presented him with a Ford motor car, in appreciation of the 'ability and determination' shown by him in 'aiding the development of the area and in proving conclusively the value of irrigated horticulture'. He was appointed C.M.G. in 1924.

Chaffey's first wife Hattie, née Schell, whom he had married in Canada aged 23, died in Mildura in 1889 leaving a young family. On a return visit to the States in 1891 he married Heather Sexton Schell at Hamilton, Ohio. Chaffey died at Mildura on 4 June 1926 survived by his second wife, two sons and a daughter of the first marriage and two daughters and a son of the second; a son had been killed in World War I. His estate was valued for probate at £11,199; his home Rio Vista became a cultural centre. A statue of him by Paul Montford was unveiled in Mildura in 1929; he was commemorated by another in Renmark in 1930.

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Alfred Deakin (1856-1919) [61]

Alfred Deakin (1856-1919), barrister, journalist and prime minister, was born on 3 August 1856 at Collingwood, Melbourne, younger child of William Deakin of Towcester, Northamptonshire, England, and his wife Sarah, née Bill, of Llanarth, Monmouthshire, Wales. William and Sarah left England in December 1849 in the *Samuel Boddington*, bound for Sydney. In March 1850 they disembarked at Adelaide, where William's married sister lived and where their first child, Catherine Sarah, was born in July. William briefly pursued his former occupations of clerk and shopman before, late in 1851, joining the exodus of men to the goldfields of Victoria. The family soon followed; by 1853 William had abandoned the fields and the Deakins settled in Collingwood (later a part of Fitzroy), where they lived as respectable suburbanites of modest means. William undertook a variety of jobs, storekeeping, water-carting and carrying, before becoming a partner in a coaching business and later manager of Cobb & Co. in Victoria.

Alfred Deakin began his formal education aged 4 at a boarding school situated first at Kyneton and later at South Yarra. In 1864 he became a day-boy at the nearby Melbourne Church of England Grammar School. Already Deakin read avidly and day-dreamed habitually, practices which hampered his academic studies. He did not excel at games. Later he looked back upon his schooldays as a time of wasted opportunities. Nonetheless, he won a few subject prizes and survived happily enough to the upper school where he came under the influence of a young master, J. H. Thompson, and the school's renowned headmaster, Dr John Bromby, whose style of oratory, which Deakin's own later closely resembled, fascinated him. At last he was inspired to work seriously. He matriculated in 1871, 'passing' in English and Latin, and 'passing well' in history, algebra and Euclid.

Deakin strayed into the study of law at the University of Melbourne. By evening he attended lectures, by day he earned pocket-money as a schoolteacher and private tutor. He spoke frequently at the University Debating Club, where he met Charles Pearson. He gained further skill and experience in the Eclectic Association of Victoria, where members aired current notions on a range of intellectual topics. He was prominent in the spiritualist movement, attending seances, testing phenomena, arranging lectures and conducting the Progressive Lyceum, the spiritualist Sunday school. In 1874 he edited and contributed to the *Lyceum Leader* and a year later his small volume *Quentin Massys: A Drama in Five Acts* appeared. In 1877 he published *A New Pilgrim's Progress*, a lengthy allegory imbued with the loftiest moral principles, and he became president of the Victorian Association of Spiritualists. He passed in 1877 the final examination for the certificate in law then required for admission to the Victorian Bar. He took chambers in Temple Court, where with little enthusiasm for law and no great expectations he wrote poetry, essays and literary criticism.

An introduction in May 1878 to David Syme of the Melbourne *Age* rescued the restless Deakin from his near-briefless career. Syme, who became a close friend, engaged him as a paid contributor of reviews, leaders, sub-leaders and general articles on politics, literature and miscellaneous topics. In 1880 he edited the *Leader*, the *Age*'s weekly. He excelled at

[61] Norris R, Australian Dictionary of Biography, Volume 8, Melbourne University Press, 1981, accessed online 13 February 2017.

journalism, which became his major occupation for some five years and provided a useful source of income for most of his life. Syme also converted him from free trade beliefs to protectionist, a change which helped both his journalistic and political ambitions. Deakin's interest in Victorian politics had been aroused by the resignation of the liberal parliamentarian, George Higinbotham one of his boyhood heroes, the entry into parliament of Pearson, and the constitutional conflict which Deakin described in the memoir (1900) published in 1957 as *The Crisis in Victorian Politics, 1879-1881*. With Syme's aid he became the Liberal candidate for West Bourke, a largely rural electorate, which he won narrowly in February 1879.

The young Deakin who entered parliament was an impressive figure. He was six feet (about 183 cm) tall, dark haired and dark eyed, his handsome, alert face fashionably bearded. He spoke rapidly in a rich, baritone voice which, he claimed, bore no trace of 'provincial' accent. In his maiden speech he startled members by announcing his resignation because of doubts about the fairness of the administration of the original poll. He lost the recontested by-election in August and lost again in the general election of February 1880, which also saw the defeat of (Sir) Graham Berry's government. In July he headed the poll in West Bourke after James Service, 'Conservative' leader, had secured a dissolution of parliament. Despite his youth and inexperience, and in the face of opposition from his own party and the *Age*, he was prominent in negotiating a compromise between moderates on both sides and helped to secure the Council Reform Act of 1881.

On 3 April 1882 Deakin married 19-year-old Elizabeth Martha Anne ('Pattie'), daughter of wealthy Hugh Junor Browne, a prominent spiritualist. The marriage, disapproved of by the Brownes, brought no material benefit to the Deakins. They lived for a time with Deakin's parents: in 1887 Llanarth, their house in Walsh Street, South Yarra, was completed. For the rest of his active life, Deakin walked, bicycled or took the tram into the city.

From March 1883 to November 1890 Deakin held office in coalition governments. He proved an able administrator, and he practised and polished the art of compromise. He introduced the Factories and Shops Act of 1885, a pioneer social measure based largely on British legislation that had impressed the royal commission of 1884. The Act, though mutilated by the Legislative Council, provided for the regulation and inspection of factories, enforced sanitary regulations, limited the hours of work of females and youths, and compensated workers for injury. He chaired the 1884 royal commission on irrigation, a cause he pressed with fervour. Late in the year he led a small party to California to investigate irrigation and conservation schemes. There he met the Chaffey brothers and reported enthusiastically on their experiments. The Chaffeys came to Victoria in 1886 and demonstrated their methods at Mildura. In June Deakin introduced the first legislation in Australia to promote an irrigation system. The bill broke with traditional English riparian law by placing ownership of natural waters under the Crown and provided for the construction of state-aided irrigation works by local trusts. Promise of early success faded because of technical problems, poor choice of associates by the Chaffeys, the depression of the 1890s and one of the worst droughts in Australian history. But in the long run successful irrigation and water schemes became a feature of rural Victoria and Australia.

Late in 1885 Berry and Service retired and were succeeded, as leaders of the coalition, by Deakin and Duncan Gillies. Deakin, chief secretary, also took the portfolio of water-supply to which was added, in 1890, health and, briefly, solicitor-general. He was Victoria's principal representative at the Colonial Conference of 1887. In London he met and impressed many prominent public figures, politicians, writers and intellectuals and formed lasting friendships. At the conference he played the role of native-born Victorian patriot pressing 'colonial' interests. He argued forcibly for better terms in the naval agreement, under which the colonies paid an annual subsidy towards the cost of an auxiliary squadron for use in Australian waters. With Sir Samuel Griffith, Service and Berry he confronted Lord Salisbury, prime minister and foreign secretary, over the issue of the New Hebrides. British officials

recognized in him the authentic, but not always welcome, voice of colonial nationalism. He returned home to a triumphant welcome.

Melbourne at this time was indeed marvellous and a massive inflow of British capital fuelled the Victorian boom. The coalition won the election of March 1889, but problems over proposed railway construction and use of the militia to protect non-union labour in the maritime strike—an action for which Deakin bore ministerial responsibility—caused the government's defeat in October 1890. By then the land boom was starting to waver and soon the bubble burst. Deakin, like many contemporaries of his social class, speculated heavily in the rush to be rich: he lost his own and his father's savings. Unlike many he repaid his debts. Nonetheless, the picture of him as an innocent intellectual unwittingly caught up in the brutal world of business seems too kind. He was chairman or director of many dubious companies, including those of the notorious boomer James Munro; Deakin's friend Theodore Fink possibly sometimes persuaded him to lend his name. As joint coalition leader he shared power and responsibility in a government whose own borrowing and investment policies contributed much to the onset of the collapse and the severity of the depression. As an individual investor he sought quick and easy profit with the rest of them.

Outwardly, after the coalition's defeat and financial disaster, Deakin seemed his familiar confident self. Inwardly, as copious note-books and diaries reveal, he was disillusioned. Tortured by self-doubt, he longed to restore his self-respect. He spent the next ten years as an influential back-bencher, the member from 1889 for Essendon and Flemington. Syme urged him to replace Munro as premier, (Sir) George Turner consulted him about the composition of his government in 1894, but he refused all offers of ministerial posts. He returned to the practice of law. He was engaged in several major cases, the most celebrated being as defender without fee in 1892 of the mass murderer Frederick Deeming, and as junior to James Purves in 1893-94 in the lengthy defence of Syme in a libel case. A respectable income at the Bar supplemented his parliamentary salary and helped to support a growing family, which in 1891 had seen the addition of his third and last daughter. In 1893 he published *Irrigated India* and *Temple and Tomb in India*, following a short working visit to India and Ceylon (Sri Lanka) financed by Syme. He read everything that came his way in English literature, biography, history and philosophy, French in the original, and German and the classics in translation. He was active in the Theosophical Society until 1896, when he resigned on joining the Australian Church, led by Charles Strong. He retained a wide interest in public affairs through the Protectionist Association, the National Anti-Sweating League, the Australian Natives' Association, the Imperial Federation League (of which he became president in 1905) and the Federal Council of Australasia. But his main preoccupation in the 1890s was the Federation movement.

Deakin's interest in Federation had been stimulated by Service and heightened by experience at the Colonial Conference of 1887, where colonial division thwarted attempts to overcome Imperial apathy. He attended all the official Federal conferences and conventions. He appears to have helped resolve differences between Gillies and Sir Henry Parkes, who convened the Australasian Federation Conference of 1890. Deakin was the youngest delegate to the National Australasian Convention of 1891 in Sydney, and he polled third in the popular election of ten Victorian delegates to the Australasian Federal Convention of 1897-98: in both he served on the constitutional committee. As a progressive liberal from a large colony he adopted a democratic stance on most issues. He opposed conservative plans for the indirect election of senators and sought a relatively weak 'States House' which he foresaw would be dominated by political parties. On the most vital constitutional issue of all, control of money bills, he tried to limit the Senate's power and make the House of Representatives supreme. He advocated wide taxation powers for the Commonwealth.

Backstage Deakin was the familiar eloquent proposer of compromises, the able conciliator, the tactful smoother of ruffled feathers. Even so, his reputation as an Australian nationalist seeking to overcome colonial parochialism, as a staunch Federationist urging delegates that

whenever they detected a Federal interest they should 'provide for it in advance', is not without minor blemish. At the first convention he claimed that special safeguards might need to be made for Victoria's protected factories. He reluctantly approved Charles Kingston's proposed new Federal arbitration power, and his remarks that it could not possibly become a 'proper subject' for Federal legislation for a very long time and might be exercised 'less satisfactorily' than by individual colonies, did little to advance the idea.

While Deakin played a significant part in making and shaping the Constitution, his contribution to the 'popular' phases of the Federation movement was probably greater. The Constitution bill of 1891 was unpopular, and politicians and public alike lacked enthusiasm. Sir John Robertson's boast that Federation was as 'dead as Julius Caesar' seemed valid and few but dedicated nationalists mourned its passing. In Victoria, Deakin set out to resurrect the corpse. In March 1893, at the annual conference of the A.N.A., he and Purves urged the association to broaden its appeals and campaigns. Deakin suggested combining with other Federal sympathizers, and (Sir) Edmund Barton was asked to create a central Federation league in Sydney. Later, Deakin prompted the Prahran branch to propose a Federation league, of which he became foundation executive chairman in 1894.

These efforts, and similar ones of Barton and others in New South Wales, took Federation out of the hands of parliamentarians, and helped to ensure its success. As chairman of the Federation League of Victoria and acknowledged leader and symbol of the cause in the colony, Deakin was the central figure in the referenda campaigns of 1898-99, when the Commonwealth bill was put to the popular test. His celebrated address at the A.N.A. banquet at Bendigo in March 1898 set the tone for the campaign and converted a hostile, but still suspicious, *Age*. A dithering Turner declared for the bill. In 1899 Deakin campaigned in Queensland, which had stood aside until it was clear that Federal union of at least four colonies was about to occur.

London staged the final act of the Federation movement. In January 1900 Joseph Chamberlain invited the colonies to send delegates for the passing of the Constitution bill through the Imperial parliament. Allan McLean, Victorian premier, appointed Deakin, who later in the month sailed for London with his wife, sister and daughters. Barton, Kingston, Sir Philip Fysh of Tasmania and (Sir) James Dickson of Queensland made up the team selected to defend the Constitution to the last comma. In the end differences came down to clause 74, which forbade appeals to the Privy Council in matters affecting the interpretation of the Constitution. At first Chamberlain deleted the whole clause. In this he was fortified by the defection of Dickson, the wavering of some colonial premiers—to whom he had appealed—and the devious conduct of several chief justices, notably Griffith and Sir Samuel Way. Deakin, Barton and Kingston put their case to the British public, at numerous complimentary functions. In the event they compromised: appeals involving constitutional issues required leave of the High Court, otherwise the right of appeal remained unimpaired unless further limited by the parliament of the Commonwealth. The triumphant trio danced 'hand in hand' in jubilation. In July, as he sailed home to a great welcome, an 'Act to constitute the Commonwealth of Australia' received the royal assent.

Deakin made a remarkable decision on his return. In London he had met Lord Glenesk, proprietor, and Nicol Dunn, editor, of the *Morning Post*. In November he accepted an offer to become their 'special' or 'Sydney' correspondent, furnishing weekly letters and occasional cables on Australian politics for £500 a year. In his just-completed manuscript (first published in 1944 as *The Federal Story*), he recorded an 'inner history' of the Federation movement. An anonymous Deakin was now to write an inner account of Federal politics for a Tory unionist paper even as he was about to become a minister of the Crown, and remain one for most of the thirteen years of his secret journalism. The money was useful and he persuaded himself that it was his duty to supply an ignorant British public with informed news and views on Australian politics. Later, in 1904-05, he was to write unsigned articles for the London *National Review*. The letters and articles were to prove vivid in style, intelligent in

comment, relatively free from bias and mildly critical of himself on occasions. By any standards it was extraordinary.

The turn of the century was a momentous time in the history of Australia and the Empire. Queen Victoria died and the South African War was being fought. Australians looked to the coming of the Commonwealth, and aspiring Federal politicians looked forward to the general election in March 1901. Deakin formed the National Liberal Organization, which united wings of the Liberal Party in Victoria, and as founder-president he espoused progressive liberal policies and selected candidates. He exchanged letters with Barton and Kingston, discussing platforms and tactics. The Earl of Hopetoun, governor-general, blundered in asking Sir William Lyne, premier of New South Wales but an anti-Federationist in the referenda, to form a caretaker cabinet. Deakin's refusal to serve under Lyne proved decisive, and Hopetoun called upon Barton.

Deakin helped to select the 'shadow cabinet' and advised on the number and nature of departments and the distribution of portfolios. He himself was sworn in as attorney-general: the youngest member of cabinet. With fellow members he devised the Protectionist policy speech, delivered by Barton at Maitland on 17 January 1901.

The first Federal election resulted in a narrow majority for the Protectionists over Free Traders. Labor came in third and declared its tactics of support-in-return-for-concessions, which in practice meant giving general support to the Barton government. Free Traders outnumbered Protectionists in the Senate, and Labor surprised even itself by winning the balance of nearly a quarter of the seats. Deakin won handsomely in Ballarat, which he held until he retired in 1913.

Federal parliament opened in May and the Barton ministry in general, and Deakin in particular, faced daunting tasks. As leader of the House Deakin was frequently in charge of parliamentary business, and as attorney-general he headed a department which drafted bills for foundation machinery and policies, and provided advice and opinions on points of law for other ministers. While (Sir) Robert Garran, his energetic departmental secretary, was indispensable, Deakin was an active attorney-general, especially in preparing opinions and drafting bills for the public service, arbitration and the High Court. On the immigration restriction bill he supported Barton against Labor, who wanted more direct methods of exclusion than the dictation test. His famous second reading speech on the bill lacked the vicious racism of many others, but his claim that Japanese must be kept out because of their good qualities, not their bad, neither pleased nor placated them. He took no part in interminable debates on the tariff, but his diplomacy in September 1902 averted possible deadlock between the Senate and House, and secured the measure which set the Commonwealth on the path to financial independence. By this time he was acting prime minister, a post he filled for six months while Barton attended the coronation and the Colonial Conference.

White Australia legislation was never in real danger and a uniform tariff had to be passed, but the Judiciary Act of 1903 needed all Deakin's negotiating skills. The Constitution provided for a High Court, but it set down no mandatory timetable for its creation and the bill met unexpected hostility. Inside Federal parliament (Sir) George Reid, Opposition leader, played politics, blaming the government both for undue haste and improper delay: many Protectionists were uneasy. Outside, State politicians, newspapers and the public condemned the proposal on State-rights grounds and with telling charges of Federal extravagance. Deakin's masterful second reading speech in March 1902 was widely regarded as a supreme example of parliamentary advocacy. In the end, passage of the bill probably owed less to the speech than to personal loyalty to 'affable Alfred' and hints of his possible resignation. While the bill to found the High Court was Deakin's most 'cherished' measure, according to the anonymous correspondent, the conciliation and arbitration bill was Kingston's. Kingston, pioneer of compulsory arbitration, became its first Federal

casualty when, in July 1903, he resigned over cabinet's refusal to extend the bill's scope to all seamen engaged in coastal trade. Deakin took charge of the measure. Most members agreed with the principle of arbitration, but disagreement arose on detail. Labor's Andrew Fisher, assisted by the Opposition, amended the bill to include State railway-workers. Deakin abandoned the bill for the time being.

When Barton retired to the High Court in September Deakin succeeded him as prime minister and minister of external affairs. He made several ministerial changes, bringing in Thomas Playford and (Sir) Austin Chapman. Deakin retained office in the December election, which produced three almost equal parties in the House, with informal Labor support. His government was short lived. He reintroduced the arbitration bill in March 1904, but Labor amended the bill to apply it to State public servants, a move he believed unconstitutional. He treated the defeat as a matter of no confidence and advised Lord Northcote, governor-general, to send for John Watson, Labor leader. Watson had less chance of keeping office than Deakin, who promised him 'fair play' provided he acquired a 'constitutional' majority. Labor, however, took office in April without making overtures to radical Protectionists such as Lyne and (Sir) Isaac Isaacs.

In May Deakin urged his party to accept Reid's terms for a working alliance though he himself would not serve in any coalition with Reid, whom he disliked and mistrusted. A divided Protectionist Party refused the offer and Watson's belated overtures. Labor pressed on with the arbitration bill until halted by (Sir) James McCay who, with Deakin's concurrence, later moved against its recommittal. Watson resigned in August after two days of bitter debate. Deakin's role in the affair marred his reputation and he lost much goodwill in parliament. Nevertheless, his own unexpected resignation, which forced Labor to accept responsibility for its actions, was a shrewd tactic. Labor's short, barren period of government curbed its irresponsible conduct and made it wary of taking office.

Deakin declined to join the Reid-McLean coalition of conservative Free Traders and Protectionists, but an opportunity for a return to office arose during the long parliamentary recess. The campaigns in New South Wales of anti-socialist leagues, which seemed much like old free trade bodies under new guise, and ideas of forming similar ones in Victoria, made Protectionists suspicious of Reid's motives. Multifarious pressure mounted to depose Reid before he called a premature election designed, the argument ran, to advantage Free Traders by prolonging the fiscal truce. Deakin warned that the anticipated reports of the tariff commission, appointed in December 1904, would inevitably disturb the truce. His speech at Ballarat in June just before parliament reassembled was regarded as a 'Notice to Quit'. Northcote's speech mentioned only one bill, and Deakin carried an amendment to the address-in-reply. Northcote refused a dissolution and called upon Deakin, who had Watson's assurance of 'cordial and generous support' for the remainder of the parliament. Reid's charges of treachery were to be expected, but Deakin's seemingly shabby treatment of the four Protectionists in the coalition, especially of Turner, lost him further goodwill and respect.

The second Deakin ministry, July 1905–November 1908, was remarkably productive. Many national policies and much practical legislation were placed on the statute books or would soon become law after the government's fall. Measures fixed the capital site, authorized the survey of a trans-continental railway-route, and provided for Australian statistics, meteorology, wireless telegraphy and copyright. The Contract Immigrants Act of 1905 established stringent procedures and safeguards for admitting contract labour, and the Commonwealth assumed full control of the former British New Guinea. The first protective Federal tariff was passed. 'New Protection' tried in devious ways to link the Commonwealth's exclusive control of the tariff with the State's power over wages and prices. The Commonwealth Literary Fund came into being and Australia involved itself in Antarctica. The Surplus Revenue Act of 1908 set the Commonwealth on the path to financial independence and dominance. Naval and military defence innovations were under way. Old-age pensions were introduced.

Most of these measures were the responsibility of Deakin's ministerial colleagues such as (Sir) William Lyne, Isaacs, Sir John Forrest, (Sir) Littleton Groom and Sir Thomas Ewing, and they were not his in any personal sense. But Deakin selected his colleagues and he led and kept in office a cabinet wherein he was manifestly not merely first among equals. Many were consensus policies favoured by members of all parties. Old-age pensions, for example, was a common cause. New Protection was neither a subtle scheme devised by Deakin to convert Labor to protection nor a Labor concession forced from Deakin, but an evolutionary policy sought by Free Traders, Protectionists and Laborites alike: none were more determined than Free Traders that if there was to be a system of protection it must take the new form. Conservative opponents of Deakin and some Labor politicians claimed that he was under Labor's thumb, the one to deny him credit, the other to claim it for themselves. Labor, however, was in a weak tactical position. Watson could not bargain or negotiate with Reid, now anti-socialist leader, and play him off against Deakin, and Labor's own brief spell of office in 1904 showed it was unlikely to govern effectively on its own.

Labor support for Deakin was vital, but it is doubtful if he conceded much in return. Though the platforms of the two parties had much in common, some policies were peculiarly Labor. None of them were implemented by Deakin, or Barton. The Immigration Restriction Act retained its indirect method of exclusion, and Deakin refused preference to unionists in his arbitration bill; there was no referendum on the tariff as favoured by Labor, no land tax or nationalization of monopolies. If anyone held the balance in parliament it was Deakin, between Labor and 'socialism' on the left and free trade or anti-socialism on the right. His negotiating skills, personal qualities and good relations with Watson enabled the Protectionist Party to retain office even after it emerged from the election of 1906 as the smallest of the three elevens. He provided stability of government enabling the passing of constructive legislation, and at the time only he seemed able to do that.

Deakin, by inclination and by virtue of his position as prime minister and minister of external affairs, was closely concerned with the related fields of 'foreign' policy, Imperial relations and defence. He took direct interest in Papua, where a faction-ridden administration limped on. In August 1906 he appointed a royal commission, which recommended the removal of the administrator, Captain F. R. Barton, and the sacking of some principal officers. In November 1908 he named (Sir) Hubert Murray, then chief judicial officer and acting administrator, as lieutenant-governor, an appointment Labor confirmed, and the thirty-year reign of the benevolent paternalist began. Deakin resumed old battles with the Imperial government over the future of the New Hebrides, urging that France be induced to accept British annexation. Apparent British ineptitude and the secretive nature of Anglo-French negotiations confirmed his low opinion of the Colonial Office. In the end, fearful of German activity in the islands, he perforce pressed for the immediate proclamation of the joint protectorate.

In March 1907 Deakin left for the Imperial Conference in London with three main aims: to reform Imperial organization, to advance the cause of Imperial preference and to revise the naval agreement. He was the most active and outspoken colonial premier on the theme that the Empire must draw closer together lest it fall apart. His proposal for a permanent Imperial secretariat to give self-governing dominions an effective voice in foreign policy, defence and economic co-operation, received a cold reception. The Colonial Office saw it as an attempt to undermine its authority, doubts about ministerial control arose and the idea lacked definition and practicality. Lord Elgin's creation of a dominions division of the Colonial Office was not much more than a change of name.

Deakin's pleas for Imperial preference as a means of strengthening the Empire politically and economically met with little support from colonial premiers and outright opposition from the British government. Sir Wilfred Laurier, Canada, was prepared to accept it if it was offered, Louis Botha, South Africa, spoke negatively. Neither, for domestic reasons, wanted further Imperial entanglements. Deakin's public campaign on the question touched sensitive issues in British politics. To conservative newspapers and Tories he was a hero, to their

liberal counterparts a villain. Asquith and Lloyd George remained implacably opposed. The Admiralty was more sympathetic to the notion of an Australian naval force, but differences on the naval agreement were not resolved.

Deakin had disliked the naval agreement since its inception in 1902, and his sustained efforts to implement Australian naval aspirations began several years before the Imperial Conference. He had also long believed in the virtues of universal military service; by December 1907, when he introduced the first bill to embrace such a scheme, Labor was about to adopt the idea and parliamentarians and the public at large had already been converted. Naval affairs, a more complex issue, inevitably involved the British government, the Admiralty, naval tactics and grand strategy, and from mid-1905 to early 1910 the subject absorbed him. He attacked the agreement and the Admiralty, and the rebuffs and insensitive denials of Australian naval ambitions merely spurred him on. Late in 1906 he announced an intended purchase of destroyers, but at the Imperial Conference the first lord, Tweedmouth, recommended submarines.

In 1908 Deakin placed further pressure on the Colonial Office and the Admiralty with his timely invitation to the American 'Great White Fleet' to visit Australian ports. By the time he resigned in November no vessels had been ordered but the Surplus Revenue Act of 1908 provided £250,000 for naval expenditure, a sum Labor used later. Eventually, after the naval scare of 1909, when Deakin played the opportunist by joining the cry for the gift of a dreadnought to Britain, the Admiralty suggested a powerful Australian fleet unit. For Deakin, the type of vessels and strategic questions such as those arising from the Russo-Japanese War of 1904-05 were secondary issues. The Commonwealth's defence power provided him with a means to two related ends, one external the other internal. An Australia prepared to share Britain's defence burden by being more self-reliant, particularly in naval defence, would earn a voice in Imperial policy. Service for the Commonwealth, especially military training for youths, would instil the 'maximum of good citizenship' and foster a 'sense of national unity' and a 'national spirit'. For Deakin acquisition of a navy and introduction of compulsory military service were essential steps in the evolution from colony to nation within the British Empire.

On returning from the Imperial Conference Deakin faced acute health and political problems. He travelled badly, slept fitfully and had frequent attacks of giddiness and exhaustion. His memory and speech faltered and he suffered a breakdown. Forrest, an old colleague, resigned in July 1907 over the Liberal-Labor relationship, which became more difficult after Watson resigned the leadership in October. Labor withdrew its support in November 1908 and the Earl of Dudley, governor-general, sent for Fisher. Deakin came under pressure to form a united front against Labor, whose militant 'machine' and electoral activities he feared increasingly. As Labor ranks had swelled at successive elections so Liberal-Protectionist numbers dwindled until the party was the smallest in the House, and its future looked bleak. Labor radicalism had outflanked and outpaced Deakinite liberalism. Neither (Sir) Joseph Cook, who had succeeded Reid, nor Forrest would serve under one another. Deakin, waiting in the wings, convinced himself that he could liberalize the conservatives and preserve radical liberalism. In May 1909 he agreed to the fusion of anti-socialists, Liberal-Protectionists and Forrest's 'corner' group. A bewildered Fisher was curtly dismissed. Close friends still believed in Deakin's integrity, but to many others his actions seemed nothing but a naked grab for power, a base move to regain office at any price by a man who thought he was indispensable. The political confusion produced some of the most dramatic scenes in Federal parliamentary history. Lyne — never a friend of Deakin and now a foe — denounced his former leader as a 'Judas', a charge which the vindictive Billy Hughes believed slandered the disciple.

Deakin was sworn in for the third and last time as prime minister on 2 June 1909. The Fusion government, given its short span of life and the few points of agreement between the uniting parties, was remarkably active. Deakin ordered the *Australia*, the nation's own

dreadnought battle cruiser and pride of the fleet unit. He invited the legendary Lord Kitchener to visit Australia to advise on military defence: later Labor largely implemented suggested changes in organization and creation of a military staff college. Bills were introduced to transfer the Northern Territory to the Commonwealth and to set up the Inter-State Commission, and one was passed to establish the high commission in London. Negotiations between Deakin, Forrest and State premiers produced the financial agreement of 1909, which gave the States *per capita* grants of 25s. annually: Deakin's attempted constitutional amendment failed in 1910, but in practice the agreement determined Commonwealth-State financial arrangements until 1927.

The Fusion government entered the election of April 1910 confident of victory, but in the event it was routed. In a heavy poll Labor gained absolute majorities in both the House and Senate. Deakin, who campaigned on a mainly negative anti-Labor platform, barely escaped defeat in Ballarat. Only a handful of his personal followers survived. He was ill-suited to the negative role of Opposition leader, especially as Labor was advancing many of his own, unfinished measures. His extensive campaign in 1911 against Labor proposals to amend the Constitution carried more conviction, but he retired in January 1913, a spent force. His last act as a politician was to support Cook against Forrest in the leadership contest.

In May 1913 Deakin emerged from retirement at Ballara, his hideaway at Point Lonsdale, to campaign against Labor's re-submitted referenda proposals. Later he declined Cook's offer of the first chairmanship of the Inter-State Commission. In August 1914 he became chairman of the royal commission to investigate wartime food supplies and prices and his colleagues carried him. As president of an Australian commission for the international exhibition at San Francisco he toured California in April 1915 with Pattie, but resigned after a renewed dispute with Hugh Mahon, Labor minister of external affairs. His health deteriorated and he visited specialists in London and New York in 1916-17. In retirement and in decline his increasingly introspective notebooks reflected his despairing sense of the emptiness of existence, the loneliness of a man spiritually and intellectually isolated for most of his life. Like many affable people he had few intimate friends, and apparently none knew the inner Deakin. After 1916 he lived as a recluse, his memory decayed, the famed silver tongue stilled. He died of meningo-encephalitis on 7 October 1919, survived by his wife and daughters. As befitted this independent Australian Briton he was given a state funeral, his coffin draped with the Union Jack. He was buried in St Kilda cemetery.

His wife Pattie, who died on 30 December 1934, was well known for her work for children's welfare, particularly the kindergarten, crèche and playgrounds movements, and for servicemen during World War I. Ivy, the eldest daughter, married Herbert Brookes, Stella married (Sir) David Rivett and Vera (Sir) Thomas Walter White. Deakin's sister Kate (or Katie) died unmarried in 1937; a talented pianist, she shared and encouraged her brother's interest in literature and remained his lifelong mentor and confidante.

Alfred Deakin, dominant figure of the first decade of Federation, was a complex character, the outer man the generally charming, confident, intelligent politician, the inner man the often morose, insecure, frustrated intellectual. The young man attracted to spiritualism and theosophy wanted to be a philosopher, poet, dramatist: instead he merely became a statesman. He was a gifted politician in an era that lent itself to his natural talents of compromise and persuasion. He had integrity, though he could play the opportunist when the need arose and the Fusion sullied his reputation for some. He was unusually modest and circumspect, declining all British offers of titles and distinctions in the belief that he had not earned them and that his independence might be compromised. In the late nineteenth century and early twentieth century he epitomized Victorian liberalism. His services to the Federation movement and the new nation were immense. The Commonwealth briefly gained recognition as a national laboratory for social experimentation and positive liberalism, and Deakin more than anyone brought that about. He was the embodiment of dual nationalism: pride in Australia went hand in hand with pride in Empire, membership of the A.N.A. with

membership of the Imperial Federation League. He had a mystical faith in the virtues of the British race and his vision was of a great white Australia living at one with and within a greater white Empire. The tragedy was that he became an anachronism. Liberalism blossomed and withered in his own time, and the middle ground disappeared beneath his feet. The sun was already setting on the Empire he envisaged.

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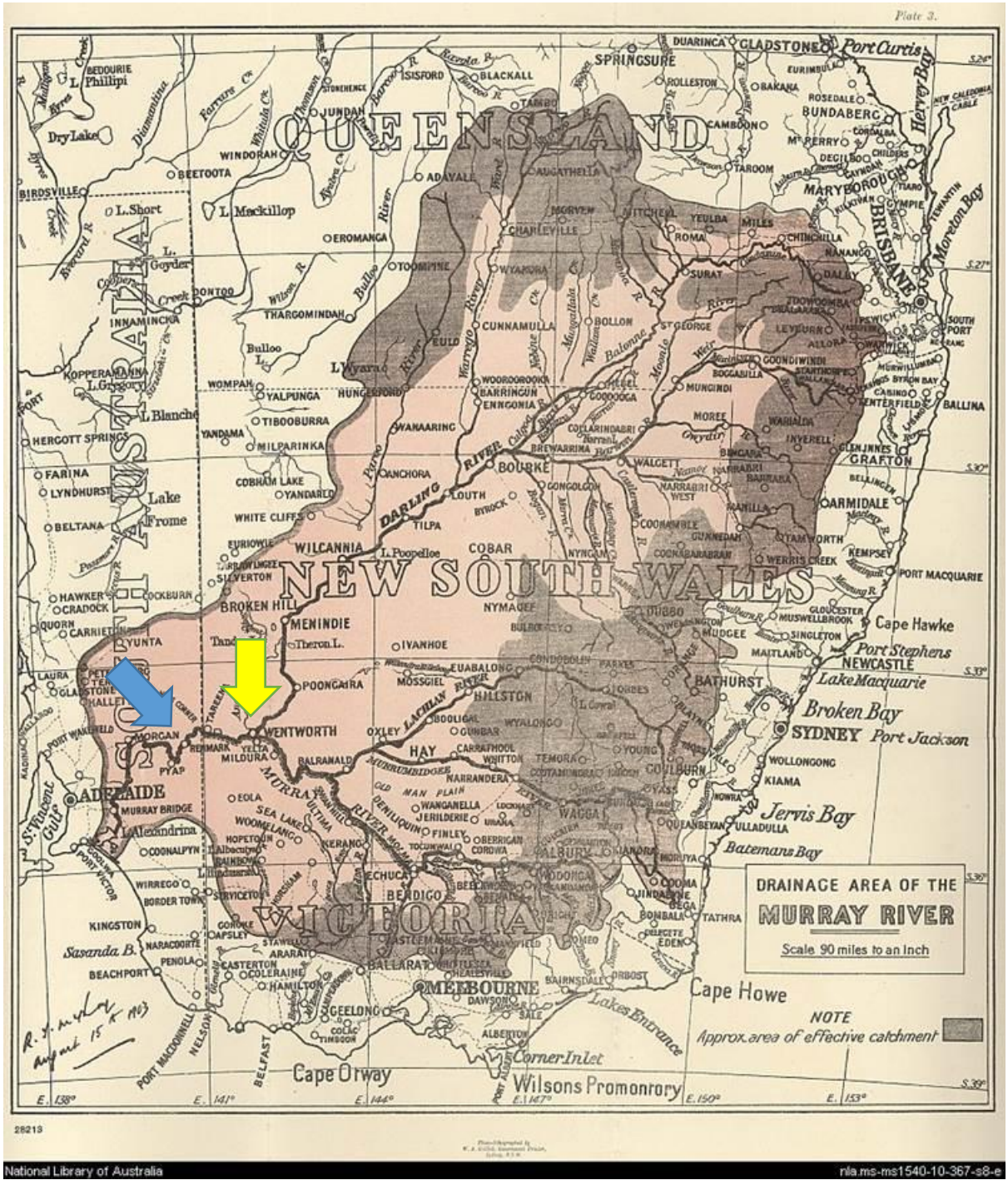
Appendix 4: Maps

Mildura irrigation area. The two main pumping stations are in the centre of the image with the centre of Mildura city at top left. *Image: Google Earth.*

Renmark irrigation area on both sides of the Murray River. The hard line of different development is the South Australian (left of line) and Victorian (right of line) state border. The darker colour on the Victorian side is natural Mallee scrub whilst the lighter colour on the SA side of the border is farmland. *Image: Google Earth.*

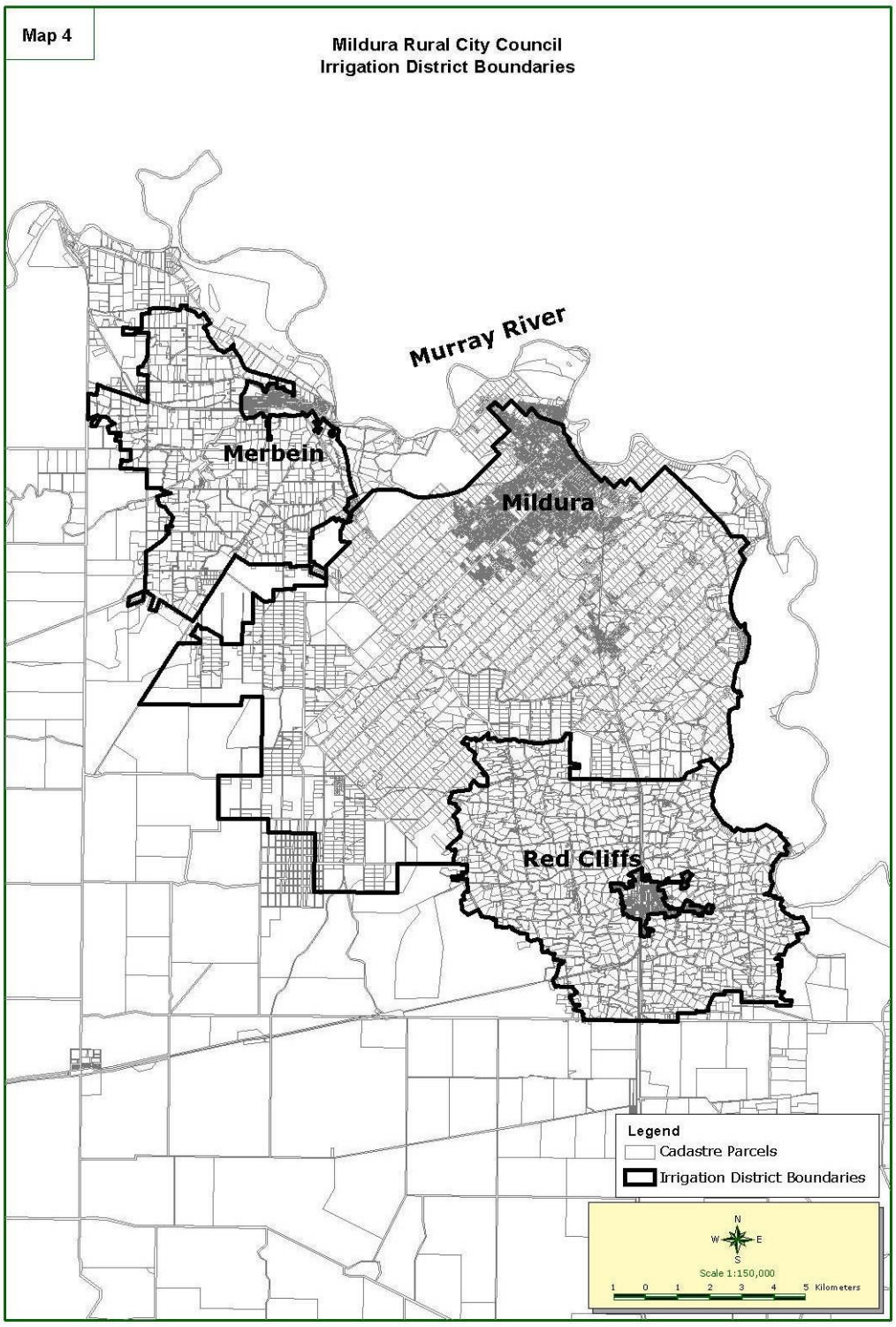


The catchment of the Murray-Darling Basin extends into the states of South Australia, Queensland, New South Wales, Victoria and the Australian Capital Territory.

The markers on the map show Mildura (yellow) and Renmark (blue), 130 km further west.

The Murray-Darling Basin (highlighted in pink above) is 1,064,469 km^2 (409,835 square miles) in area; 3375 km (2097 miles) in length measured from north east to south west and the principal river, the Murray River is 2508 km (1558 miles) long.

Image: National Library of Australia.

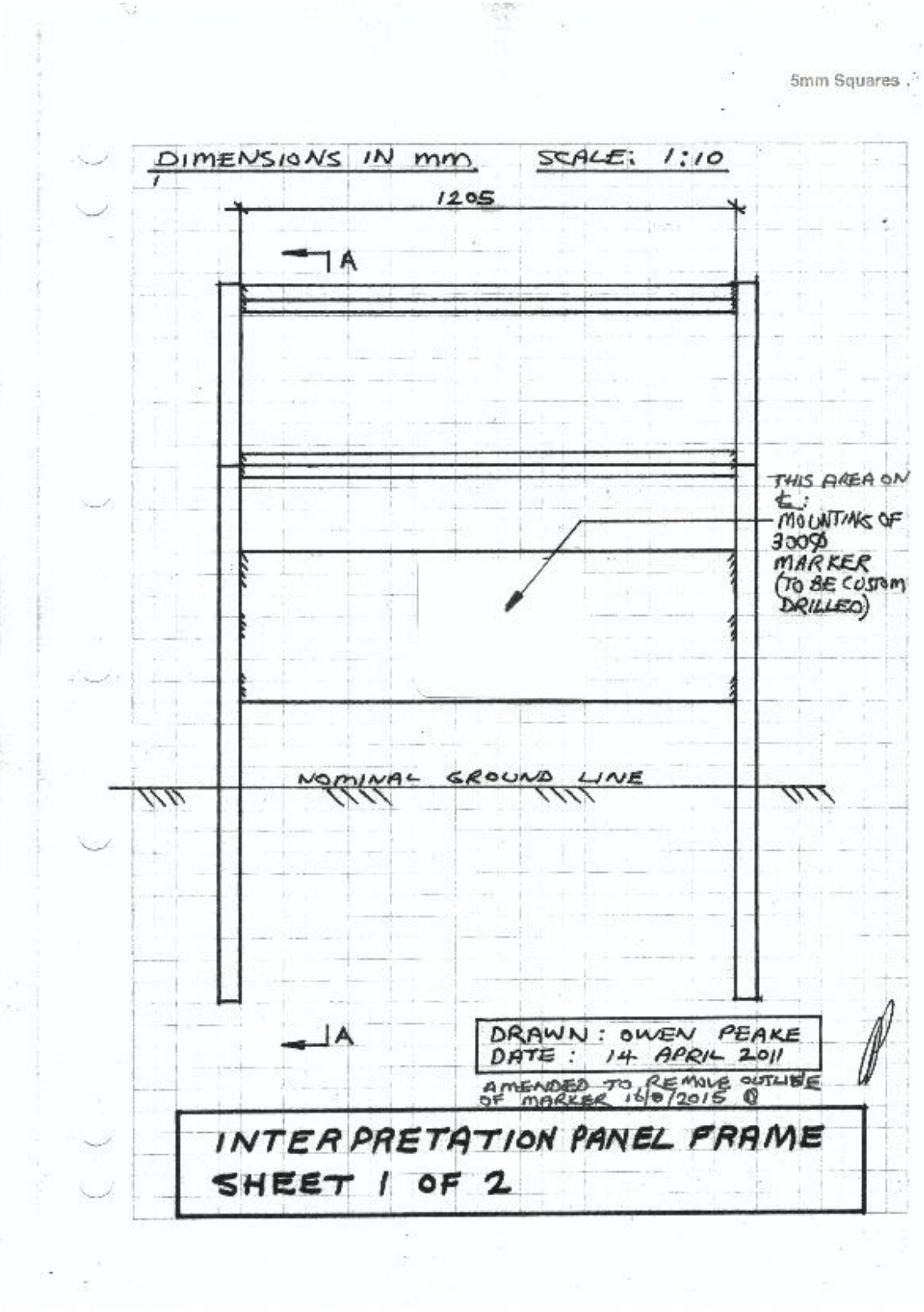


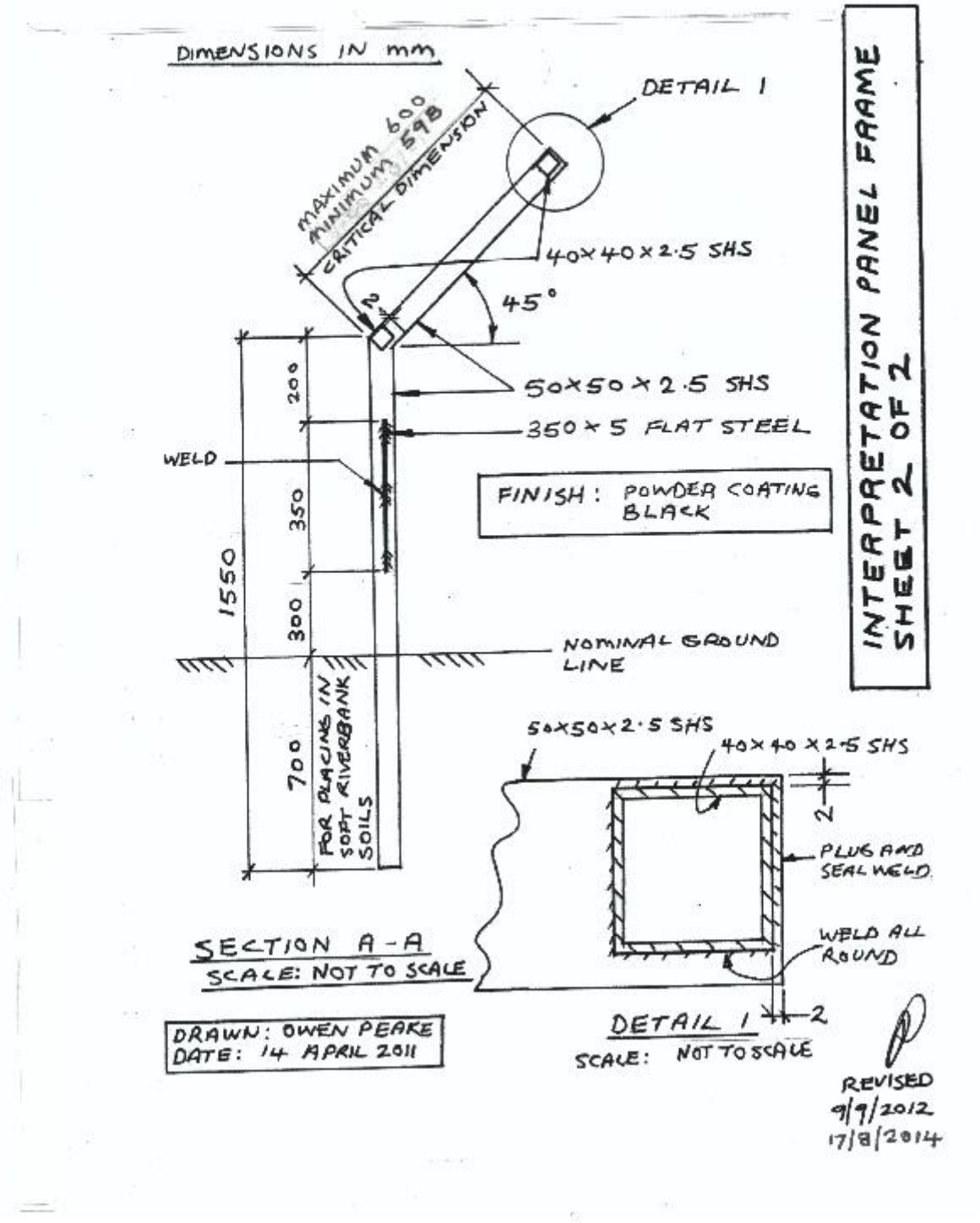
Boundary of Older Irrigation Areas. ***Image: Mildura Rural City Council.***

Appendix 5: Time Line for Key Dates for the Chaffey Brothers Irrigation Projects in Australia

1848	George Chaffey born Ontario, Canada.
1856	William Benjamin Chaffey born Ontario, Canada.
1877-1884	Drought in Victoria.
1885	Alfred Deakin visits the United States to look at irrigation projects and meets the Chaffey Brothers.
1887	The Indenture signed for the Mildura irrigation project.
1887	Agreement signed with south Australian Government.
1890	Population of Mildura passes 3300, population of Renmark passes 1100.
Early 1890s	Mildura project besieged by many problems.
1893	Stuart Murray, Chief Engineer for Water Supply instructed to report on complaints against Chaffey Brothers Ltd.
1894	Chaffey Brothers Ltd goes into liquidation.
1896	Royal Commission to inquire into the failures at Mildura.
1897	George Chaffey leaves Mildura for the United States.
1897	William Benjamin Chaffey decides to stay in Mildura and works for the community for the rest of his life, becoming a pillar of the community.
1926	William Benjamin Chaffey dies at Mildura aged 70.
1932	George Chaffey dies in the United States aged 84.

Appendix 6: Drawings of proposed Interpretation Panel

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SHEET 2 OF 2
DETAIL 1
MAXIMUM 600
MINIMUM 598
CRITICAL DIMENSION
40X40X2.5 SHS
45°
2
50X50X2.5 SHS
350X5 FLAT STEEL
WELD
FINISH: POWDER COATING BLACK
1550
200
350
300
700
NOMINAL GROUND LINE
FOR PLACING IN SOFT RIVERBANK SOILS
SECTION A-A
SCALE: NOT TO SCALE
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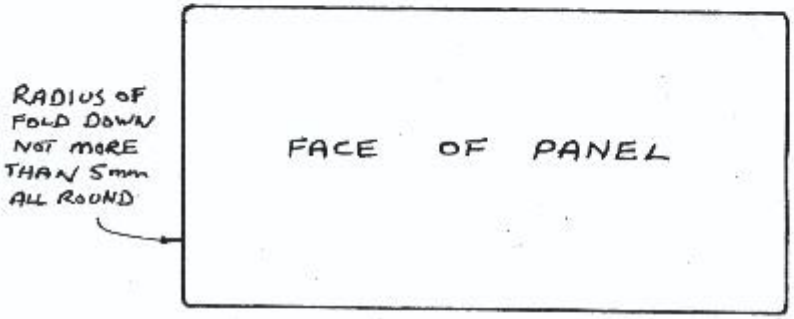
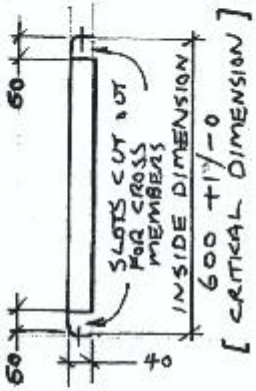
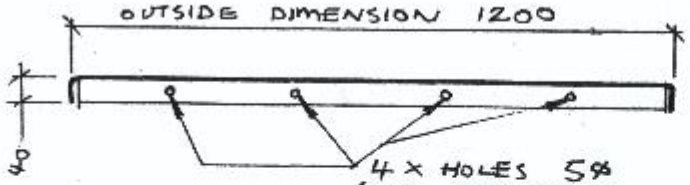
40X40X2.5 SHS
PLUG AND SEAL WELD
WELD ALL ROUND
DETAIL 1
SCALE: NOT TO SCALE
DRAWN: OWEN PEAKE
DATE: 14 APRIL 2011
REVISED
9/9/2012
17/8/2014

DIMENSIONS IN mm

SCALE: NOT TO SCALE







NOTES:
1) EDGES FOLDED DOWN ALL ROUND 40 mm
2) PANEL DESIGN: CUSTOM DESIGN, SCREEN PRINTED ON STEEL SUBSTRATE IN VITREOUS ENAMEL

INTERPRETATION PANEL

VITREOUS ENAMEL PANEL GENERIC

DRAWN: OWEN PEAKE
DATE : 14 APRIL 2011

REVISED 8/7/2014

Appendix 7: Letter of approval from Psyche Bend Historical Reserve Committee

To be added later

Change Control

CHANGE CONTROL			
VERSION 1	**8 FEBRUARY 2017**	**2720 WORDS**	
VERSION 2	**10 FEBRUARY 2017**	**4365 WORDS**	
VERSION 3	**13 FEBRUARY 2017**	**13275 WORDS**	
VERSION 4	**20 FEBRUARY 2017**	**18991 WORDS**	**MINOR EDITING; ADDED APPENDIX 2**
VERSION 5	**4 AUGUST 2017**	**19003 WORDS**	**MINOR EDITS BC**